Popular Science
MONTHLY *Founded 1872*

February
1928
25 cents

In this Issue **"What Doctors Dont Know About Diet"**

All the New Discoveries and Inventions

When sore throat rules the house

Mothers should present the facts to a great novelist and let him write of the trials of a woman whose three children and husband are at home for a week or more with a cold.

Fretful little Junior . . . his sniffling sisters . . . the irritable father out of his element . . . the worry of wondering whether it is just a cold or something worse.

Can such trying sieges be avoided? Oftentimes, yes.

Listerine, the safe antiseptic, used early has checked many and many a cold before they had a chance to get the upper hand.

At the first sign of irritation use Listerine full strength. As a gargle. As a mouth wash. And occasionally diluted, as a nasal douche.

You will be delighted to find what threatened to be a nasty cold is often gone in a day or two.

The antiseptic action of Listerine explains its ability to check cold weather complaints. The moment it enters the mouth it attacks the disease-producing bacteria that lodge there.

The intelligent thing to do is use it systematically during these cold weather months when "flu" and pneumonia are a constant menace. Lambert Pharmacal Company, St. Louis, Mo., U. S. A.

Do something about it - - -

LISTERINE

-the safe antiseptic

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

WHAT IS NEW THIS MONTH

Table of Contents for February

LEADING ARTICLES

FICTION

RADIO

THE HOME WORKSHOP

Agriculture

Automobiles

Aviation

Exceptional People

Health and Hygiene

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Laboratory Discoveries

Meteorology

Models

New Devices for the Home

New Processes and Inventions

Photography

Radio

Ships

Unusual Facts and Ideas

For the Home Owner

Hints for the Mechanic

Ideas for the Handy Man

Are You Abreast of the Times?

If you can't answer the questions below, turn to the page indicated

1. Why were clothes invented? (p. 48)
2. What billion-dollar industry sprang from a college boy's crucible? (p. 35)
3. What nation has the largest submarine? (p. 34)
4. Why aren't blondes brunettes? (p. 45)
5. What is the climate seven miles above the earth? (p. 57)
6. What is the principal problem in constructing an electric radio set? (p. 78)
7. Why has an inventor produced luminous golf balls? (p. 53)
8. What are the nine wonders of the modern world? (p. 11)
9. How much of yourself could you do without? (p. 61)
10. What is the dam that surprised engineers when it didn't break? (p. 18)
11. Is fried food healthful? (p. 49)
12. Why haven't helicopters gone up thousands of feet? (p. 44)
13. Why does a telephone lineman take a running jump when he mounts an electrically charged pole? (p. 37)
14. How many kinds of wood are commonly used in home building? (p. 65)
15. What is the best way to kill moths? (p. 52)
16. How does science make its own "divining rods?" (p. 56)
17. How does Pupin, electrical savant, believe life came to the earth? (p. 21)
18. What kind of metal can't burglars' torches pierce? (p. 31)

Overhearing A TALK About INVESTMENT TRUSTS

By WALLACE AMES, *Financial Editor*

A REGULAR foursome at the country club consists of Dr. Mark Atkins, Tom Kelsey, Asst. Secretary of a large insurance company, Larry Strong, Vice-President of an oil burner company and Allen Kirby, banker. One of the first to start play each Saturday afternoon, they generally get through in time to sit around the locker room and chat a while before going home to dinner.

"Everybody seems to be interested in investment trusts these days, at least when their interest is in investment matters instead of aviation, sensational murders or who 'chooses' to run for the Presidency. But most of what I have heard or read about investment trusts has been in financial lingo, so I do not yet know clearly what they are all about."

Thus spoke Dr. Atkins, who was just a layman in investment matters, hoping to get some enlightenment from his banker friend Kirby.

Tom Kelsey, always ready to start a little razzing, took his cue: "I suppose 'financial lingo' is as clear to you as one of your 'simple' discourses on a favorite medical theme is to us."

And from Larry Strong: "What do you want to know about investments for? Has some patient paid one of your outrageous bills?"

"That's enough of your wise cracks," said the Doctor, good naturedly. "Dry up and give the floor to a man who knows something. I was talking to a banker, not to you two wits."

THE BANKER'S STORY

When the banker began, the rest listened more seriously, for they were all interested in knowing more about the subject of investment trusts. And he had the faculty of expressing himself simply and clearly. "I realize that many explanations of the investment trust have been clouded with technical expressions, but there is no need of them.

"It will be easy for you to understand the subject if you first comprehend a certain similarity between an investment trust company and any other business corporation, such as a railroad, bank or steel mill.

"When a corporation is started the first thing it does is to raise capital, by selling its stock and bonds to investors. That is exactly what an investment trust does.

'Using its capital to buy property, equipment, supplies or merchandise, the railroad engages in the transportation business, the utility in the electric power business, the store in retailing, the industry in manufacturing, etc. With its capital an investment trust engages in the business of making investments. Each corporation conducts its particular line of business as a means of making money for its bond and share holders.

ADVANTAGES OF AN INVESTMENT TRUST

"If you own a share in a railroad you own a part of its net assets; if a bond of a public utility, certain property is pledged as your security. If you own a share in an investment trust you own a part of its net assets, which are in the form of securities rather than physical property; behind your investment trust bond are the securities owned by the trust.

"In short, any business corporation, including an investment trust, is simply employing capital to make money for its share and bond holders."

"Is it not a fact," inquired Dr. Atkins, "that a conservative investment trust buys standard securities such as I could buy for myself? And does not the operating expense of the trust come out of the return on these securities so that my profit is less than when I invest direct?"

"The answer is yes and no," said the banker, but as that seemed to be no explanation at all he went on to elaborate.

"Yes, the trust buys the same securities that you could buy and probably at the same price. Yes, their operating overhead comes out of the gross return on securities owned before they pay interest or dividends on their own bonds and stock. But it is unlikely that you would do as well investing direct.

"The investment trust gives you the safety of extreme diversification which you cannot get with any ordinary sum invested in a few securities. It also gives you the profits of expert management. There are other advantages, but let us confine ourselves to these two: diversification and management.

"Kelsey, here, will tell you that diversification is the very backbone of the strength of his insurance company. They can insure a *(Continued on page 6)*

Overhearing a Talk About Investment Trusts

(Continued from page 4)

man today, collect one premium and pay his death claim tomorrow without ever feeling the pinch. By insuring many lives the diversification of risk takes care of the exceptional case.

"Another reason an insurance company is so strong financially is because its assets are invested all over the world, a little here, a little there, no great proportion risked in any one venture or locality.

"In the same way, an investment trust with its millions of assets secures the safety of wide diversification. I know one trust that has 157 different investments. They represent governments, municipals and 29 different basic industries situated in 24 separate countries. Another trust has over 400 diversified investments.

"You alone couldn't diversify so widely unless you had a million or more to work with. Yet, when you buy one share or one bond of an investment trust you participate prorata in its diversified holdings.

"Diversification is not only an element of safety; it is also a factor in profits. One way to make an investment income is through interest or dividends. Another way is to buy low and sell high. If you have a participation in a hundred good securities you have one hundred times the chance to make a market profit that you have if your money is all tied up in one. You have a hundred chances for stock dividends or other extra profits that frequently occur in prosperous times.

"The investment trust movement is founded, at least partly, on the fact that investing is a profession. For the average man to pass judgment on which securities are best for his case and to undertake the management of his holdings is not unlike a sick person attempting to treat himself with the aid of the old family doctor book.

"Making an investment is proper selection in the first place. Then it is necessary to keep in constant touch with the affairs of the enterprise in which you have invested and with economic conditions in general. This is essential in order to know when to sell to avoid a possible loss or to cash in on an exceptional profit opportunity.

"Such management requires professional skill and training as well as elaborate statistical records and other facilities. It means constant vigilance. With such facilities and such skill a well-managed trust attends to its investments."

"Pretty good *(Continued on page 6)*

Overhearing a Talk About Investment Trusts

(*Continued from page 5*)

sort of scheme, I should say," chimed in Tom Kelsey.

"Well," concluded the banker, "it is a plan that originated in Great Britain a long while ago, I think in the 1860s and it has been going strong on the other side ever since. We just took it up within recent years. Undoubtedly our people were ready for the plan, if the fact that they have already invested over half a billion dollars in investment trust stocks and bonds is any criterion.

"Drop in the office any time if you are interested in further dope, or in making an investment. I'll try to help you out."

"Thanks, Allen, I'll be there soon," said Dr. Atkins.

"So'll I," said Larry Strong.

"Me, too," said Tom Kelsey, and the foursome broke up for the day.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"Ideal Investments" is the designation universally accorded Smith First Mortgage 6½% Bonds which carry attractive tax refund features. A history of the House and information relative to their bonds and the safeguards that surround every issue they offer, may be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

Behind the Scenes Where Bonds Are Made tells how you can retire in fifteen years and have an income equal to your present living budget. This booklet can be secured by writing to Cochran and McCluer Company, 46 North Dearborn Street, Chicago, Ill.

Thirty-two page illustrated booklet, describing one of the largest public utility companies, of interest to investors. Utility Securities Company, 230 S. La Salle St., Chicago, Ill.

The Common-Sense Test of Investment Trusts suggests an easy method by which you may correctly judge the worth of any investment trust before putting your money into it. United States Fiscal Corporation, 50 Broadway, New York, will send a free copy if you request Circular CS.

"The Making of a Good Investment" tells how 6½% can be made on investment in First Mortgage Bonds in units of $50, $100, $150, $500 and $1000; how the bonds are protected and how simple it is to purchase them. For a copy of this booklet address United States Mortgage Bond Company, Limited, Detroit, Michigan.

How to Get the Most Out of Your Radio Investment

The Popular Science Institute has prepared a booklet that gives definite and helpful advice in buying, installing and operating a radio outfit. This 20-page radio booklet can be obtained for 25 cents from the Popular Science Institute, 248 Fourth Ave., New York City.

How the Lumber Industry uses Tycos, the Sixth Sense ~

AS IN every industry where manufactured products are put through heat treating processes the lumber industry has substituted the accuracy of *Tycos* Instruments for guesswork in lumber drying. And the change to *Tycos* Instruments for indicating, recording and controlling temperature is saving the industries of America literally millions of dollars annually.

Two of the important factors in lumber drying are temperature and humidity. One of the chief advantages of kiln drying is that it is possible to maintain proper drying conditions independent of weather conditions, thereby controlling the drying process and the final moisture content. It is practically impossible to maintain proper drying conditions by hand adjustment of spray and heat-line valves. Regardless of the operator's experience it is not within human ability to change instantly the position of the hand valves so that proper temperature and humidity will always be maintained. *Tycos* Instruments will insure uniform quality and loss from spoilage.

Whether you make lumber or steel, or furniture, ice cream, tools, candy, or any other product that goes through manufacturing processes that require the indicating, recording or controlling of temperature there is a type and style of instrument in the *Tycos* Line of 8,000 varieties that will help you. Informative literature on any type of instrument will be sent you promptly on request. Or our engineer will consult with you on the application of *Tycos* to your particular manufacturing problem.

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ROCHESTER, N. Y. - - U.S.A.
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SHORT & MASON, Ltd. Manufacturing Distributors in Great Britain

Tycos for the Home

Tycos Office Thermometers
An aid in promoting human efficiency.

Tycos Bath Thermometers
To enable you to get the most good from your bath.

Taylor Home Set
Bake Oven Thermometer, Candy Thermometer, Sugar Meter. The secret of accurate results in Cooking.

Tycos Wall Thermometers
To help you maintain a temperature in your house conducive to good health.

Taylor Quality Compasses
To show you the right way in unfamiliar country.

Tycos Fever Thermometers
A necessity in every home.

Tycos Stormoguide
Forecasts the weather twenty-four hours ahead with dependable accuracy.

Tycos Hygrometer
To enable you to keep the humidity of the atmosphere in your home correct at all times.

Tycos for the Medical Profession

Tycos Sphygmomanometer, Pocket and Office types.

Tycos Urinalysis Glassware.

Tycos Fever Thermometers.

Your dealer will show them to you.

Ask us, on a postal, for booklets on any of the above.

THE ~ SIXTH ~ SENSE ~ OF ~ INDUSTRY

Tycos Temperature Instruments

INDICATING ~ RECORDING ~ CONTROLLING

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What Is *Happening* to RADIO

By
Alexander Senauke, E. E.
Assistant Director
Popular Science Institute of Standards

RADIO, as an industry, is not what it was in 1920 or even 1926. For this we should be grateful.

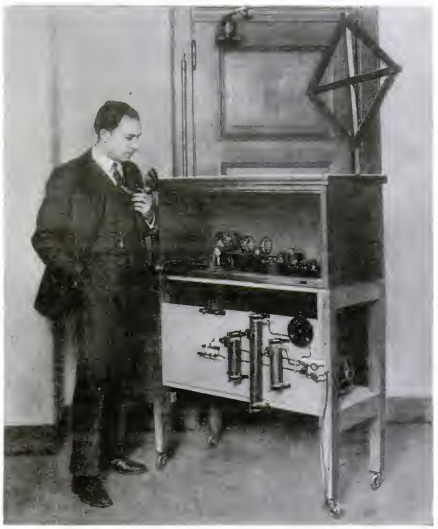
Radio is now entering an era of stabilization and standardization, brought about much quicker than was hoped for, and there are several forces to be credited largely for this.

In the matter of stabilization we find that licensing agreements have been reached giving manufacturers and the public the advantage of the application to radio products the results of the researches of the most able physicists, scientists and engineers in the world.

Two very definite advantages result from such stabilization. It means the elimination of irresponsible radio manufacturers and will lead to *quality* competition rather than *price* competition.

As to standardization, we find the efforts of the national associations, such as the National Electrical Manufacturers Assoc. and the Radio Manufacturers Association, are bent upon the standardization of general manufacturing practices, manufacture of small parts, and the establishment of standard performance tests and possibly even performance standards.

Just what will this do for the public? It means that increasing production economies will consequently result in decreased prices. It assures higher performance standards. It provides common basis performance claims in advertising. And, lastly, it decreases the rate of obsolescence of major products due to minor changes.



This test arrangement Mr. Senauke is using was developed by him three years ago and provides a means of checking accurately certain features of receiving sets

The Institute of Standards has for three years provided the readers of POPULAR SCIENCE MONTHLY with many of the advantages that will benefit the general public when the efforts toward national standardization are fully accepted by the industry.

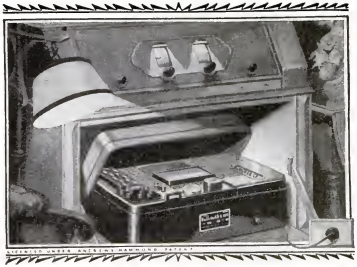
Through its tests and the establishment of its own standards, the Popular Science Institute has been able to advise readers what radio equipment could be considered reliable and provided a means for excluding from POPULAR SCIENCE MONTHLY the advertising of products found to be unworthy of the term "standard merchandise."

The Popular Science Institute of Standards fully appreciates the problems and welcomes the efforts of those organizations engaged in establishing standards and in obtaining their acceptance by the radio industry.

It is interesting to note with regard to the standardization of test methods, that many of the test arrangements that are being recommended for general acceptance at this time are basically, and frequently in detail, equivalent to test methods that have been independently developed by The Institute's staff and used by it for more than three years. It is now the intention of the Popular Science Institute's directors to expand the radio laboratory facilities to include every test arrangement that is recommended as standard by the associations of the radio industry, thus extending the value of its work.

* * *

A twenty-page booklet on buying, installing and operating a radio outfit, as well as a list of tested and approved radio equipment, can be secured for 25 cents from the Popular Science Institute, 250 Fourth Avenue, New York, N. Y.



Now AC Electric Radio

Licensed under Andrews-Hammond patent

To owners of a "B" eliminator:

Balkite "A" is like Balkite "AB" but for the "A" circuit only. It enables you to make an electric installation at very low cost. $35.

Balkite "B"

The accepted, tried and proved light socket "B" supply. One of the longest lived devices in radio. Three models, $22.50, $35, $42.50.

Balkite Chargers

Standard for "A" batteries. Noiseless. Can be used during reception. High rate or trickle. Three models, $17.50, $9.50, $7.50.

There are special models for 25-40 cycle current at slightly higher prices. Prices are higher West of the Rockies and in Canada.

Without the uncertainty of untried apparatus

And without any sacrifice in quality of reception

Of course you want an AC electric receiver. For its convenience. Now you can have it, without the uncertainty of untried apparatus and without sacrificing quality of reception.

Simply by adding Balkite *Electric* "AB" to your present radio set. Balkite *Electric* "AB" replaces both "A" and "B" batteries and supplies radio power from the light socket. It contains no battery in any form. It operates only during reception. It makes any receiver an electric set.

This method makes possible the use in electric reception of standard sets and standard type tubes. Both are tried and proved, and give by far the clearest and truest reproduction. With this method there is no waiting for tubes to warm up. No difficulty in controlling volume. No noise. No AC hum. No crackling or fading of power. Instead the same high standard of reception to which you are accustomed.

In this method there is nothing experimental, nothing untried. It consists of two of the most dependable products in radio—a standard set and Balkite. And if you should already own a radio set, the cost of equipping it with Balkite is only a fraction of the cost of a new receiver.

By all means go to AC reception. Its convenience is the greatest improvement in radio. But be as critical of an AC receiver as you would of any other. Let your AC receiver be a standard set equipped with Balkite *Electric* "AB." Then it will be as clear and faithful in reproduction as any receiver you can buy.

Two models, $64.50 and $74.50. *Ask your dealer.* Fansteel Products Co., Inc., North Chicago, Illinois.

Chicago Civic Opera

on the air Thursday Evenings, 10 o'clock Eastern time. Over stations WJZ, WBZA, WBZ, KDKA, KYW, WGN, WMAQ, WBAL, WHAM, WJR, WLW, WENR. 10:30 Eastern time: WEBH, KSD, WOC, WOW, WCCO, WHO, WDAF.

BALKITE HOUR

Balkite ELECTRIC AB

contains no battery

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To prevent communication with the outside world, Antony closely surrounded the city of Modena with his army and stretched nets across the river. Brutus, in charge of the defense, easily thwarted these measures by the simple expedient of fastening letters to the feet of carrier pigeons.

Surmounting Barriers—Neither winter snows, nor impassable roads, nor sickness itself can bar you from contact with world events. Whatever the reason for your isolation, a Grebe Synchrophase Seven bridges the gap, bringing you concerts, sermons, lectures, music, sporting events in such clear, full, life-like fashion that you are one of the audience. You forget it's radio.

The Synchrophase Seven, especially when combined with the Grebe Natural Speaker, is unrivaled in naturalness of tone. It is easy to operate, exceptionally pleasing to look at. The durability of its many superior qualities is assured by that sound construction which for nineteen years, has been a synonym for the name "Grebe."

Grebe Synchrophase Seven, $135. Grebe Natural Speaker, $85. Send for Booklet P. Then have a Grebe dealer prove, in your home, that you can "get it *better* with a Grebe."

GREBE SYNCHROPHASE RADIO

TRADE MARK REG. U.S. PAT. OFF.

A. H. Grebe & Company, Inc., 109 West 57th Street, New York City

Factory: Richmond Hill, N. Y. *Western Branch:* 443 So. San Pedro Street, Los Angeles, California

Makers of quality radio since 1909

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Popular Science MONTHLY

FEBRUARY, 1928 SUMNER N. BLOSSOM *Editor* VOL. 112, NO. 2

Nine Wonders *of The* Modern World

Dr. Samuel W. Stratton, President of Massachusetts Institute of Technology, Selects Marvels of Today Beside Which Those of Antiquity Seem Commonplace

By EDGAR C. WHEELER

THE ancient world had seven wonders. All were architectural and artistic. You may still recall them—the Pyramids of Egypt and the Sphinx, the Hanging Gardens of Babylon, the Tomb of Mausolus in Asia Minor, the Temple of Diana at Ephesus, the Colossus of Rhodes, the Statue of Jupiter Olympus in the valley of Olympia and the Pharos (Lighthouse) of Alexandria. Marvels of many centuries, all were built by the slavery of drudgery with crude implements. Time has left but one—the Pyramids and the Sphinx.

The modern world has wonders far different, vastly more magnificent. They are achievements of applied science, created not by slavery, but by mastery of Nature's forces to the use of mankind. They are on every hand. So commonplace have many become that we have almost ceased to marvel. They have changed the whole course of life; yet never have they been tabulated as were the wonders of old.

TIME and again, POPULAR SCIENCE MONTHLY has been asked to list the Seven Wonders of the Modern World. Seeking an answer, the Editor invited several hundred leading Americans each to name seven examples of applied science which they considered the greatest. An analysis of their replies brought forth a list of some fifty works representing useful applications of discoveries in virtually every field of research.

Dr. Samuel W. Stratton, President of Massachusetts Institute of Technology, who strove in vain to include the stupendous marvels of the modern world in a list of seven. He covered the story in nine

Now came the problem of choosing from these the seven most important. It called for the judgment of an expert. The Editor asked me to present the question to a man eminently capable of giving an authoritative opinion on the outstanding examples of applied science—Dr. Samuel W. Stratton, President of the Massachusetts Institute of Technology, formerly Director of the United States Bureau of Standards.

I FOUND Dr. Stratton at his desk in a great gray building of science overlooking the Charles River at Cambridge, Mass. A staunch built, iron gray man of wide technical experience, he guides there the endeavors of hundreds of young men in training to wrest new wonders from Nature.

"Seven!" he exclaimed. "You mean I am to reduce the wonders of today to just seven? It can't be done! Why, it would be more reasonable to name seven hundred and seventy-seven wonders!"

He read down the list—agricultural machinery, airplanes, aluminum, anesthesia, antitoxins, automobiles, bridges—and so on to the end of the alphabet.

He took up a pencil and began to scratch off certain items. He threw down the pencil.

"It can't be done!" he repeated, and begged to be excused. Students were waiting outside his office; he would not

delay them. Meanwhile he would consider the question.

Later I returned. Dr. Stratton was still struggling with the list. I waited. Five o'clock—five-thirty. A voice on the telephone reminded him he would be late for dinner. Six o'clock. Another call told him he was late. Six-fifteen. He rang for his secretary. Six-thirty. He handed me, reluctantly, a typewritten sheet of paper.

On this sheet—nine wonders of the world!

Seven vanished wonders of old, changed to nine through the miracle of progress!

The list, without attempt to list the wonders in order of importance, appears on this page. In nine short sentences you may read the whole amazing story of modern discovery and mastery.

Still, Dr. Stratton was dissatisfied.

"IT IS the best I have been able to do, but far from perfect," he complained. "See"—he pointed— "I have failed entirely to mention chemistry; yet the application of chemistry lies at the heart of most of the wonders I have listed."

Indeed, it was a chemist; the son of a humble French tanner, who laid the foundation for the first great wonder, "*the discovery of bacteria and the application of bacteriology to human welfare.*" By revealing the perpetual onslaught of these myriad microscopic creatures on all living matter, Louis Pasteur first led the world from black ignorance and superstition to scientific understanding of disease. And by application of his discoveries to the relief of human sufferiug, he armed mankind against its subtlest enemies. As a result, infections and plagues have been beleaguered and conquered, until today the people of the world enjoy better health and longer life than ever before in history.

It was less than seventy years ago that Pasteur, searching a brewery for the cause of "diseases" that spoiled wine and beer, discovered that fermentation is not "spontaneous," but the work of tiny one-celled creatures. He revealed that the atmosphere swarms with these invisible beings, which we have learned to call germs or bacteria, in countless varieties, ready to invade and prey upon every form of organic substance, whether it be the juice of a grape or the blood of man. He went on to discover bacteria that caused certain diseases in animals and men, and to learn to control and banish them.

TODAY a thousand varieties of bacteria are known, and hundreds of laboratories are devoted to their study. Bacteriology has become a science in itself. To Pasteur we owe the use of antitoxins and other modern methods which bid fair to control all forms of infectious diseases. Diphtheria, smallpox, typhoid fever, cholera, influenza, dysentery, scarlet fever, among others, have been robbed of much of their terror. Within the last year discovery of an antitoxin for the treatment of erysipelas has been announced, and an antitoxin for measles promised for the near future. Marvelous antiseptics have revolutionized surgery. Modern sanitation, protection of water from pollution, and preservation of food have made life possible in crowded cities. In twenty-five years the span of life in America has increased from fifty years to nearly sixty, while the annual death rate since 1880 has dropped from nearly twenty per thousand of population to less than twelve.

Revelation of the processes by which soil bacteria break down organic matter, producing nitrates which plants use for food, has brought vast benefits to agriculture through scientific soil fertilization and crop rotation.

AGAIN, researches in chemistry and in physics laid the cornerstone for the second great wonder Doctor Stratton named—"*the progress of our knowledge of the constitution of matter and radiation phenomena.*" It began with the conception of atoms as the invisible building blocks of the universe—an idea resurrected from ancient Greece and presented to the world in revised form at the start of the nineteenth century by a British chemist, John Dalton. It grew to majestic proportions with the discovery of radium, in 1898, by the French physicists, Pierre Curie and Madame Curie.

This and subsequent explorations into the wonderful world of atoms stand among the great triumphs of all time. For they have revealed all matter in the universe as a changing, evolving thing, pulsating with swift motion, and charged with enormous energies which man may some day learn to harness.

From the theory of atoms has emerged the magic of modern chemistry in extracting useful by-products from raw materials, in developing valuable compounds, and in creating man-made materials to match Nature's own.

FROM the discovery of radium hurling forth streams of electric particles at tremendous velocities, has come the conception of atoms as midget solar systems whose planets are whirling electrons, and finally the theory that all forms of matter, living or "lifeless," are simply amazing collections of vibrant electrical energy, radiating through space as light, heat and other more mysterious forms.

This new understanding of matter as a dynamic, changing thing already has placed enormous forces under human control. The uses of radium emanations, X-rays, ultra-violet rays, strangely powerful cathode rays, presage even greater marvels. Today physicists are studying the riddle of the penetrating cosmic rays that bombard the earth from outer space. Knowledge of light radiations have enabled astronomers to measure distant stars and learn of the elements composing them. Discovery and control of electromagnetic waves have given us the wonders of radio.

MANY years before electricity was given a meaning and a place in the foundation of the universe, inventors were designing the third wonder—"*the progress of electricity as to light, power and communication.*" Electricity was bridled to the service of man.

When Michael Faraday, early in the nineteenth century, induced an electric current in a coil of wire by moving it across the field of a magnet, he comprehended little of the mighty forces with which he dealt. But out of his experiment came the first dynamo and the first magneto, forerunners of all our machines for generating electricity.

Increasing knowledge brought a succession of marvels—the telegraph of Morse, the telephone of Bell, the incandescent lamp of Edison, heating appliances and electric furnaces, the wireless of Marconi, radio, television—any one of which overshadows in magnificence any of the seven wonders of old.

Electricity, little more than a curiosity half a century ago, has revolutionized industry by the economical production and distribution of power. It runs our factories, moves our trains, illuminates our homes, starts our automobiles, relieves drudgery, bridges time and space, and unites nations.

The fourth wonder—"*the internal combustion engine and its application*"—has wrought changes almost as astonishing. Only forty-three years have passed since Gottlieb Daimler constructed his

THE NINE WONDERS OF THE MODERN WORLD

A List by Dr. Samuel W. Stratton

The discovery of bacteria and the application of bacteriology to human welfare.

The progress of our knowledge of the constitution of matter and radiation phenomena.

The progress of electricity as to light, power and communication.

The internal combustion engine and its application.

Modern methods of structure building with both metal and cement.

Modern metallurgy.

Processes of food preservation, including canning and refrigeration.

Aircraft and aerial navigation.

The development of machinery to lessen the burden of labor and to increase its output.

A vista of modern progress. Without the nine wonders listed by Dr. Stratton in the accompanying article, the achievements of applied science symbolized here could not have been attained. Flying machines, skyscrapers, motor cars, electric power and appliances, the conquest of disease through revelations of the microscope—all have been reared by the practical applications of scientific research

first successful gas engine and used it to run a bicycle. Since then the power derived from combustion of the mixture of gas and air has eclipsed the agencies of transportation which have endured since the beginning of history.

NEARLY 28,000,000 motor cars now rolling over the world's highways, about 23,000,000 of them in the United States. America has one pleasure car for every six persons. Economies of quantity production have placed the motored vehicle within reach of almost every man and built a record-breaking industry representing billions of dollars. Though the basic principle of the gas engine has not been altered since Daimler's day, swift improvements in machinery and materials have brought power and speed under perfect control. No other single invention has worked such sweeping changes in human life and habits.

Adding to the wonder are the powerful and highly efficient motors that have made possible the spectacular advances in aviation. Without them the recent epochal ocean flights never could have been achieved. Increasingly important, too, is the development of oil engines, and particularly the Diesel engine, which is gradually replacing less efficient steam in the propulsion of ocean vessels.

THE fifth wonder on the list Dr. Stratton calls "*modern methods of structure building with both metal and cement.*" This may not sound particularly magnificent, until you consider that it has created virtually all the mighty engineering achievements of modern times—our great skyscrapers, bridges, ships, dams, subways, canals, tunnels, engines and machines. With steel and concrete, modern builders, in a few months, erect structures which would have required years of labor for the builders of the Great Pyramid.

THE use of iron to build machines and implements goes back half a dozen centuries, and iron was first employed in an important way as structural material more than a century ago. The Age of Steel, however, might never have been realized but for the experiments of a British metallurgist and inventor, Sir Henry Bessemer, in the search for improved metal for artillery. The result of his experiments, (*Continued on page 114*)

The Movie Maker

All of the romance and secret wizardry behind the screen revealed in a stirring, vivid novel

By
S. W. NEWMEYER

Illustrated by Ernest Fuhr

On the edge of the cliff stood Margaret Moreland. She raised her arm. Steel gleamed in the moonlight

"ONE million, seven hundred thousand, twenty-three dollars—*and eighty-seven cents!*" Jacob Eckstein's moan rose to an anguished wail, but he was too disheartened to pound the desk with his usual fervor. "And not yet a picture! With so much money Carleton could've bought all the sheiks in Arabia and shipped them home in gold cages for personal appearances."

"Lemme see the bad news." Ed Porter, general manager of Popular Players West Coast studio, twisted his cigar to the other corner of his capacious mouth and stretched out a hand for the accountant's sheets on the president's desk.

Jacob Eckstein had arrived in Hollywood that noon on a flying trip from the New York office, where he presided actively over the distributing end of the business. All afternoon he had been on the lot with his general manager, noting the various stages of completion in the pictures being made by the three producing units in California. His fourth and de luxe unit, under the direction of the great Carleton, had been abroad for nearly a year making a gigantic historical spectacle under the working title of "The English Slave." Month after month costs of the picture had risen, yet it was still far from completion—and not until a picture gets out of production and into distribution do its figures jump from the red into the black, as Eckstein knew so well. That was what had brought him West with sudden decision. But the activity on the lot that afternoon had not raised his spirits, and at five o'clock he had watched the day's rushes in the projection room with a steadily sinking heart. No winners there; though, in spite of his gloom, he had chuckled unexpectedly at the slapstick rushes.

Another chuckle now sounded in the gathering dusk of the office. Porter looked up, his finger on an item. As he read it aloud, the president of Popular Players winced, his small black eyes contracting with pain.

"'To replace costumes stolen by Arabs —$5,000.00'"

"And not even did they wait for Carleton to shoot the scene—thieves!" The black eyes smouldered; then, thinking sadly of his squandered money, the little man behind the big mahogany desk inquired plaintively, "Couldn't Carleton find robbers enough in California that he had to go to Arabia to hire them?"

"BUT that wouldn't have been local color," protested Porter with a grin, "and you know Carleton makes his brag on never faking a scene. When the script calls for a sequence in the Arabian desert, all the sand and sheiks in California won't do. Why, he won't even let the Pacific Ocean double for the Atlantic!"

"I know—I know." Eckstein nodded his gray tufted head like a melancholy bird. "And for that, Popular Players must now suspend production for six months."

"That'll hit some of our people pretty hard." Porter's broad, good-natured face lengthened into seriousness. "But we've felt it coming. Do we close down tight?"

"A month will finish the pictures we're now shooting, won't it?"

"Just about. Jack O'Malley's shot a few scenes of 'Mixed Husbands,' and Heller's started casting for the South Sea super-special—"

"Super-specials!" shrilled Eckstein. "This company's skidding into bankruptcy on super-special tires. Stop 'em both!"

"'Brick' Kennedy spoke to me last week about buying a story for that feature picture you promised to let him make. Said he had a great script for it. But I stalled him."

"HE ASKED me on the lot today could he see me tomorrow. Too bad I got to disappoint him." Eckstein shook his head thoughtfully. "He's a bright young fellow and makes us money on those slapsticks. He can make a camera do tricks, that boy! Less retakes than any other director on the lot, and we don't pay him hardly more than a good camera man. But we won't have cash enough to even make two-reelers till we stop pouring money in 'The Slave.'"

"And if that's a flop—"

"You got to see it won't be! Put Sims in charge tomorrow till we close down; you get ready to go at once to Arabia and—"

Judy seized Don's hand and pumped it vigorously. "I'll work for nothing—when do we start?" she asked. "This minute," said Don. "You're on the payroll now. Nothing an hour and double that for overtime"

"Carleton's in Constantinople now."

Eckstein groaned.

"Catch up with him quick before he thinks he's got to shoot a scene in China. He's resigning on account of a nervous breakdown from overwork—"

"A breakdown!" Porter interrupted, astonished.

"Oh, he don't know it yet, but he will when he gets my letter. Then you take charge and finish the picture—and bring that bunch of globe-trotters home! If 'The Slave' grosses big, we open the West Coast studio again. If it flops, like the last one, we better go through bankruptcy."

"What about contracts?"

"MORELAND'S the only long term we got left. It runs yet a year. Can't we sell her to Earle Pictures—for half price, maybe?"

Porter's eyes twinkled at the fire-sale instinct that would offer the beautiful but fading Margaret Moreland to a rival at a bargain. He shook his head.

"She's always starred in Carleton's pictures. When he didn't take her abroad, everybody knew she was through. And after 'Frozen Hearts' opens on Saturday, you won't be able to get rid of her at any price. Did you see the rushes?"

Eckstein nodded slowly and pronounced the death verdict.

"I saw. She looks old. But what to do? A thousand a week for another year—and Moreland just resting? We break her contract!"

"She'd sue—and you're not ready to declare bankruptcy."

"Not yet," confirmed the president, despondency settling down on him.

"Well, I'll get things started for the finish now." Porter walked briskly to the door.

"Don't forget to say the shut-down is temporary," warned his chief.

"I'll ease it to them," promised the other, and the door closed on him.

* * *

The six o'clock sun of an August morning beamed with increasing brilliance on a group of forty or fifty people clustered at the intersection of two of Hollywood's street-car lines. Among them were a dozen or so assorted flappers, several housewives with market baskets and bundles, three or four women standing with their hands on baby carriages in which the infants were rolled-up blankets neatly and deceptively bonneted. Two workmen, with bundles of tools, lounged against a lamp-post at the outer edge of the group, smoking. A paper hanger and his helper sat on their push-cart, which bulged with rolls of paper. At the end of the long planks protruding beyond the cart swung a pail filled to the brim with paste. And around and about the group, like lively waterbugs, darted several small boys on roller skates.

But they, as well as the other individuals, were paying close attention to a tall, homely young man in the center of the group, whose brick-red hair, recently plastered flat with water, was drying in the sun into little flaming shoots that bounced with the energy of his movements.

"Light's strong enough now. Have to hustle and finish before traffic begins. Long shots first and no retakes. You all know your places." He glanced at the script in his hand. "Numbers one to five at the grocery store. Six, seven, and eight enter the bank, nine and ten leaving it . . . "

As he ran through the list, his two camera men stationed themselves at strategic angles and the extras scattered to their places, several entering small cars of a popular make parked along the curbs. After glancing sharply up and down the two streets, where the actors stood motionless in place as though under a spell, the red-haired young man gave the script to a girl in a dilapidated car parked some distance from the camera.

"Everybody here, Brick?" she asked, handing him a small megaphone.

He nodded and, standing beside the car, blew a shrill whistle.

IMMEDIATELY the corners came alive with the bustle and activity that would animate the place in reality a few hours later. Young girls strolled down the street arm in arm and singly. Housewives chatted and exhibited their babies to one another. Two of the roller-skating small boys, rounding a corner nearest the camera, bumped into a fat policeman and ricochetted into the paper hanger's cart, with a great splashing of paste on everyone in the vicinity.

A double whistle shrilled, and all action on the streets paused. The camera men moved to the curbs. Don Kennedy, otherwise known as "Brick," again blew a single blast, and the automobiles became the focus of action. While the camera men ground at a fraction of their usual speed, the automobiles were driven into a traffic tangle at snail's pace. Two street cars, with good-natured crews and a few interested passengers, were

pressed into service and moved gently to an apparent collision at the trolley crossing, while flivvers dodged at slow motion around them, jumped from track to track, got themselves caught in the collision, and did everything but leap over the tops of the street cars.

The drama proceeding in the midst of all this motion commanded by the red-haired young director was the pursuit of an eloping couple by the bride's father, the fat man of the comedy. With others of the cast, bride and groom scrambled from car to car, became wedged between street cars and automobiles, and escaped death a dozen times by carefully calculated inches. At last, leaping into the car of the villain, they tore down the street at two miles an hour, followed by the remainder of the company on foot and in automobiles.

AGAIN the double whistle. The camera men stopped cranking, the cars returned and picked up those who were walking, and the whole crew set out for their next location.

Don Kennedy looked at his watch and jumped into the rickety old car beside the girl who held the script.

"Seven-twenty," he remarked, as he kicked the starter. "Finished that up in pretty good time. We'll make the studio by ten-thirty. Everything safe?" He glanced hastily over his shoulder at a small, battered suitcase in the tonneau. Although he grinned at his companion as if amused at his own anxiety, there was an undercurrent of excitement in his tense voice, in the quick sparkle of his cheerful blue eyes.

Judy Burke's shining, pansy-black eyes sent back an answering sparkle. A flush glowed through the even tan of her round cheeks and her dimples pricked deeper.

"I'm so excited I could jump up and down and *scream!*" she confessed, her voice catching in a nervous laugh. "To think we're just on the edge of our big picture! How much do you suppose they'll give me for the script?"

"Two thousand, maybe."

"Not any more? Eckstein paid a hundred thousand for 'The English Slave.'"

"Greedy! But that was a published book with a sensational sale—even if yours is a better story," he added quickly. He looked down at his companion with an expression of brotherly worry. "Look here, Judy, you mustn't count too much on this, you know. Maybe the whole thing will fall through."

"But Eckstein *promised* to let you do a program picture next, and you know how he praised you yesterday before everybody."

"Yes, but I've been hearing rumors about an economy schedule and—"

"WELL, that's just where you shine!" Judy reminded him triumphantly, tossing her straight, thick black bob out of her eyes like an energetic Shetland pony. "And when you explain your invention to Eckstein and show him how you can turn out a super-special for less than the cost of an ordinary program picture, he'll hand you the whole lot to play with."

"Hope so." Don drew up to the curb of a sparsely built residential street far out in the suburbs. The paving was half finished and a huge steam roller stood at one end of the street, ready to begin the day's operations. The other cars were arriving, and as Don put his long, corduroy-clad legs over the closed door at his side of the car, Judy hopped out at the other side, a small, sturdy figure in khaki riding habit, a gay bandana at her throat. With the script bent open at the next scenes to be shot, she followed Don around as he gave instructions to the camera men and actors.

Judy was that little famed but very important accessory in any motion picture studio—the script girl. It was her job to follow the scenario scene by scene as it was shot, jotting down any changes made in the sequences, noting scenes omitted or added, and checking up in minute detail the costumes worn and the properties used in every set and location.

Five years before, at the age of fourteen, she had obtained her first job as extra in a schoolgirl comedy at Popular Players; on the same day Don had begun work there in the laboratory. Two years later Don had become second camera man of the comedy unit, for which Judy occasionally worked. Within another two years, through hard work, ingenious use of camera tricks and technique, and a lucky break or two, he had become director of the unit, making Judy his script girl. And, as the usual slapstick comedy is merely a loose—very loose—fabric thrown around the dummy of an idea and pinned together with gags, they worked out the scenarios together. But they had a shining goal ahead—a big picture some day, scenario by Julia Burke, direction and new photographic process by Donald Kennedy.

Judy's eyes snapped as she automatically noted the details of the scene. By noon they would surely have Eckstein's answer on the big picture project. Then, before another year had passed, Don would be a justly famous director, and Judy herself would be refusing offers of fifty thousand—no, a hundred thousand—dollars for her scenarios.

The haughty lady scenarist of the future was jerked back to present action by Don's whistle.

"Ready—camera!"

The small automobile in which the eloping pair had fled was tilted on end against the front of the steam roller, as though it had collided with it and had been jolted skyward. In the front seat of the machine were two dummies clothed to resemble the bride and groom of the picture. As the first camera man began to grind very slowly, an actor hidden on the farther running board tumbled the dummies out on to the road in front of the camera. When shown on the screen, of course, the slow taking of this scene would result in such a rapid projection of it that the substitution of the dummies would pass unnoticed.

THE moment the dummies landed on the road, the first camera man stopped grinding, the hidden actor jumped clear of the car, and the actors playing the eloping couple were helped into its front seat. Then the second camera man turned his crank slowly in reverse motion as the steam roller backed gradually away from the flivver, allowing it to settle to the road. When auto and roller were level, nose to nose, the camera was stopped for a moment while the engine of the car was started. This accomplished, the second camera man resumed his slow reverse cranking while steam roller and automobile backed away from each other, the bride and groom, as well as the operator of the steam roller, registering terror. Projected on the screen, this slow reverse photography would result in the apparent rushing together of automobile and steam roller.

Don blew his whistle twice, the assistant camera man flashed the slate with the scene number on it, and the crank of the camera twirled to a stop. A few moments later it was turned again in slow reverse, as the steam

(*Continued on page 158*)

Don was silent, but Judy, glancing at the determined angle of his square, big-boned chin, knew he was suppressing with difficulty his excitement for that all-important interview

Toys That Save Millions

Grand Fey Viaduct, near Fribourg, Switzerland, built from celluloid model below at left

The $5 celluloid model from which the greatest Swiss railroad bridge, above, was designed

Testing model to find strength of a skew arch, nearly impossible to learn by mathematics

Celluloid Viaducts, Dams and Skyscrapers Tested by Artificial Cyclones and by Floods Made with Mercury to Determine How Real Ones Can Be Built Safely

By ALDEN P. ARMAGNAC

ACROSS the Potomac, the Arlington Memorial Bridge is being pushed to completion. Six massive piers are finished and ready for the superstructure; and the end of next year will probably see a 2138-foot roadway joining Washington, D. C., with the South. This bridge, the most notable monument built by the nation in recent years, bears witness to the successful application of an entirely new principle in bridge design.

Before the first foundation had been laid, engineers watched a flat celluloid model of one of the bridge's arches twist out of shape under a microscope. That view saved the Government about $25,000. Another look at a different type of celluloid model told them that heavy granite blocks could be hung on the sides of the bridge, to enhance its beauty, with safety.

TO TELL engineers how great structures will bend and twist under whatever loads they may bear, Prof. George E. Beggs, of the Department of Civil Engineering at Princeton University, invented an ingenious apparatus. In his system, scale models, quickly cut from sheet celluloid, reveal in a few minutes what might require months, or be utterly impossible, to calculate with figures.

Prof. George E. Beggs using micrometer microscope to study effects of pressure on a celluloid model of a bridge arch with fixed ends. The effects are called identical with those of like degree on a real arch

This is but one of the remarkable ways that experts now seek to determine new facts about the behavior of skyscrapers, bridges, and dams. In California, for instance, a great dam has been built solely to see how such a structure reacts to the pressure of the countless tons of water it holds back.

Other researches are telling builders how to make buildings earthquake-proof. In North Carolina, a condemned bridge was recently seized on by engineers as a splendid means of tests to find out how much weight a bridge can carry. A "Cave of the Winds" at the U. S. Bureau of Standards is investigating "exploding buildings" and the effect of wind on skyscrapers and high smokestacks.

THE house you live in, the ground you walk on, the building you work in—these to your eye seem rigid enough. But suppose for a moment you have eyes that see in microscopic dimensions. The fiber of this very paper appears as open as mosquito netting. Your watch's hour hand is a mighty beam moving at express-train speed. Now the stone and steel of which men build structures appear as quivering masses of jelly. The earth they rest on is shivering and shaking, too.

Nothing, after all, is really rigid. That girders of steel and beams of reinforced concrete can support tons of shifting weight is due not to their stiffness, but to their elastic strength. They bend, or sag, and spring back none the worse for it—

Slenderest and only full size test dam, 60 feet high, which has held back a volume of water that spread California mountains apart

Reading the telemeter, left, which shows interior pressure, and strain gage of the great test dam

provided the load has not been too great. How much is "too great?" That is what the engineer is for—to tell us that. From such tests as those in great testing machines at the Bureau of Standards, he knows how much weight a given steel girder can safely carry. The arrangement of those beams in any given bridge pattern tells him, through his knowledge of the science of mechanics, what weight each one will be called upon to bear. That is, it generally does. But a few problems have him stumped.

FOR instance, not long ago an important highway was built running twenty miles north out of New York City. To eliminate delays at street intersections the commission in charge decided to bridge all important cross streets. Ordinary concrete arch bridges would have required a high "hump" in the middle, with long approaches, or else, if made flatter, exceedingly heavy abutments; for such bridges are flexible, and "give" a little under traffic. These bridges are easy to design and are therefore generally used in all except the largest projects, even where others would be less costly. But the commission decided on flat, "rigid" bridges, both for beauty and economy of materials.

Because so-called rigid, one-piece concrete structures do not yield in any particular direction under a load, but are deflected throughout their entire structure, they are the nightmare of the engineer. One pier bends this way, another one that, and the result is often a terrifying mathematical problem with two dozen different unknown quantities to be determined. So the commission sought the advice of Prof. Beggs, who recommended celluloid models.

One day's work with the models," said Arthur G. Hayden, consulting engineer for the commission, "accomplished results that agreed exactly with those obtained by a week's tedious mathematical analysis." The bridges were soon completed at a saving of $5000 each over the flexible type bridge that might otherwise have been required.

The greatest railroad bridge in Switzerland—the huge, "rigid" Grand Fey Viaduct near Fribourg—was designed from a celluloid model that cost exactly five dollars. With a similar model, Prof. Beggs showed the engineers of the Arlington Memorial Bridge that, in considering it flexible, they had not taken advantage of the added stiffening strength given by the superstructure. Cutting down their materials only a part of the amount his model indicated, they saved $25,000.

Another celluloid model showed what no one had been able to calculate—the effect of the heavy granite facing. One engineer feared the roadway would crumple, and even suggested additional granite slabs as counterweights in the middle of the bridge. The model showed his fears groundless; the ninety-foot road would sag only one sixteenth of an inch at its edges! "Mathematical calculations, here, were not possible," Prof. Beggs said.

BUILDINGS, factories, dams, and tunnels like the recently completed Holland Tubes of New York have yielded their secrets to the models. Now that solid arched concrete factory walls as well as one-piece floors, long popular in Europe, are coming into favor here, such a simple means of designing them is important. How strong the joints of building trusses must be to withstand earthquakes is shown by the models. The squeezing effect of tons of water and silt on an under-river tunnel is graphically shown and reveals where tunnel rings need greatest reinforcement. And through his flexible models Prof. Beggs was able to assure authorities of Princeton University that their football stadium would bear a new four-inch concrete surface.

Prof. Beggs cuts out a piece of celluloid to scale, to represent the bridge arch or building truss he is testing. Through the use of ingenious gages, pressure, also carefully proportioned, is then applied at the points where the load and other forces will eventually rest.

The model bends or twists; a point on it, the point being investigated, moves. Through a microscope Prof. Beggs watches and measures the degree and direction of the movement, which show exactly what the deflection of the finished member will be!

"I believe a great field for these models," Prof. Beggs told me, "lies in the design of such structures as the Westchester bridges above New York City—small structures where difficulties in design have hitherto prohibited the use of the most economical and attractive types.

"The models will probably not replace usual design by calculation in places like New York, where for ordinary buildings the well-known formulas are entirely adequate. But in Tokio, for instance, and other cities plagued by earthquakes, there is great use for them. From seismograph records the forces unleashed by an earthquake are readily learned, and with models the buildings can be designed to resist these known forces.

"It is possible, too, that models may be used to check what happens in big dams, such as the proposed Boulder Dam in Colorado."

The idea of using models first occurred to Prof. Beggs, he said, when he was commissioned to compute the deflections of the great "rigid" Bessemer-Lake Erie Bridge over the Allegheny. Calculations were tedious. Prof. Beggs noticed that the deflection curves he obtained bore a striking resemblance to the shape of a thin wooden pole bent out of line. He tried using a wooden pole to predict the results, and found that it would show in a few minutes' work what it had previously taken days to calculate. Encouraged, he tried cardboard models, then celluloid. The last proved most satisfactory.

Prof. Beggs showed me a model of a bridge arch cut out in fifteen minutes with a jig saw. In a few minutes' examination it revealed all the essential facts about the arch. Near by was a pile of papers, three inches thick, covered with figures—a student's solution of a similar problem.

"Yet the model tells facts the calculations do not," Prof. Beggs said, "and it is error-proof. Nature never makes mistakes. And models solve any structural problem in the most natural way."

WHILE Prof. Beggs was making his diminutive models other engineers were not idle. Modern dams are more slender than their predecessors, and to test the theory that a safe one could be made even slimmer the Engineering Foundation, a great association of research engineers, did just that—a unique exploit.

To their surprise, the sixty-foot-high Stevenson Creek Test Dam near Fresno, Calif., withstood the terrific pressure, even when a freshet sent water over the top. There is (*Continued on page 128*)

Nations Join *to* Sound Seas

World Experts with New Instruments Will Plumb Last Depths

By JAMES N. MILLER

EXPLORERS of many nations are preparing to embark on what may be the most far-reaching voyage of discovery since Magellan sailed around the globe. With ingenious new instruments they propose to penetrate and chart the "deeps"— those vast black canyons of mystery that lie miles down under the oceans.

Sounding the depths of seas that cover 140 million square miles, or nearly two thirds of the earth's surface, they expect to reveal the secrets of some of the world's last unknown regions. They hope to trace the birthplace of destructive earthquakes, and perhaps to discover great submerged volcanoes.

A SCHEME of international coöperation in this enormous undertaking was formulated a few weeks ago by scientific representatives of twenty-nine nations at a meeting of the International Geodetic and Geophysical Union in Prague, Czechoslovakia. The plan was made possible by newly devised instruments for taking accurate soundings far beyond the limits at which human divers or submarines could hope to survive.

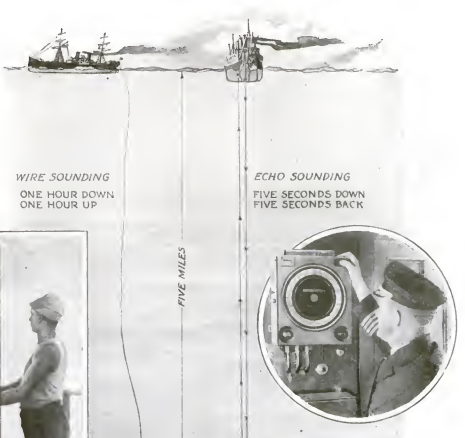
Unwinding a six-mile piano wire by machinery to get, after an hour or more, a sounding that will only approximate the sea's actual depth

Until now the challenge of the deep has gone virtually unanswered, for explorers have had no effective means of measuring the miles-deep sink holes. From meager soundings they have learned, however, that the canyons of the ocean floor surpass anything known on land. The Grand Canyon of the Colorado, averaging about a mile deep, ten miles wide and 280 miles long, is a small gully compared with the enormous labyrinths beneath the sea.

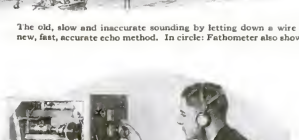
The great Aleutian Deep, largest under the Pacific, is estimated at five miles deep and 1500 long. Beginning off the coast of Alaska, it parallels the Aleutian Island chain; then, extending toward Kamchatka, merges into another huge canyon that stretches past the Japanese islands, east to the Philippines and finally to the South Sea Islands, where it splits into various deeps of smaller dimensions.

The great Nares Deep, biggest hole in the Atlantic floor, drops 27,972 feet, more than five miles. It covers an area nearly equal to the state of Maine. The Mexican Deep sinks 18,000 feet. Other huge declivities include the Tonga Deep, off Samoa, and the Java Deep. The deepest spot yet found, 145 miles southwest of Tokyo, goes down six miles. This enormous hole could swallow Mount Everest, highest peak in the world!

Heretofore miles of heavy piano wire with heavy leads attached have been used—a laborious and inaccurate process taking an hour or so for a single sounding.



The old, slow and inaccurate sounding by letting down a wire and the new, fast, accurate echo method. In circle: Fathometer also shows depth



Using the sonic depth finder, which, by timing the echoes the ocean bottom sends to its signals and translating the time into distance, takes more than 14,000 soundings an hour as the ship steams along

Before a submarine could dive even a mile it would be crushed by the water pressure.

Operation of the new sounding instrument, the sonic depth finder, already used effectively by the U. S. Coast and Geodetic Survey, is placed in the bottom of a ship and sends down rapping noises, catching their echoes from the ocean bottom. Since the speed of sound is known, the depth can be calculated from the time between transmission of the sound and reception

(*Continued on page 121*)

Stars Hold Secret of Life

Invisible Rays from Heavenly Bodies Stimulate Growth at Order of Divine Power, Says Noted Electrical Authority

By ARTHUR A. STUART

A SAVANT in the dark ages attempted to create life by black magic. He used such terrifying ingredients as the hair of a bewitched dog, snake oil, wolfsbane, toad's eye, deadly nightshade, extract of vampire, a portion of black cat and a bit of rooster's comb snipped off by moonlight. Was the recipe a success? Only too much so, if we are to credit legend of the period. In fact the worthy necromancer overshot his mark and created a monster, lawless and devastating, useless and dangerous, which was suppressed with the greatest difficulty.

For some ages science put aside the life problem. Then, within our time, Jacques Loeb hatched an unfertilized sea urchin egg by treating it with salt, and a Rockefeller Institute colleague demonstrated the apparent immortality of human or animal tissue kept in a suitable medium and temperature.

Today Michael I. Pupin, world authority on electrical phenomena, tells us that the production of life in an earthly workshop is the small end of the problem. Life is not a mechanical accident, nor did it originate on this planet by a spontaneous chance. It may come here from the stars; at least it is revitalized by surges of majestic rays, invisible to the human eye but with a penetrative force greater than any other known.

Pupin, devoutly religious, finds no trouble in reconciling his theory with Genesis II, 7: "God formed man of the dust of the ground, and breathed into his nostrils the breath of life."

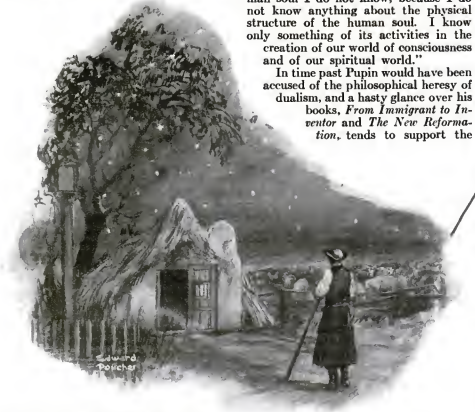
MOST scientists avoid theology, but this one invokes it. "Electrons are the building stones of the universe, seen and unseen," said Pupin recently, "and I believe God created them. He endowed these building stones with attributes which make everything in the universe rise to higher and higher levels. This rise is observed everywhere in the life of the luminous stars, as well as in the life of plants and animals. It can be observed in the evolution of atoms, from those of lower atomic weights, like hydrogen, helium and lithium, to those of higher weights, such as gold, lead, uranium and radium.

"Whether the same building stones are employed in the construction of the human soul I do not know, because I do not know anything about the physical structure of the human soul. I know only something of its activities in the creation of our world of consciousness and of our spiritual world."

In time past Pupin would have been accused of the philosophical heresy of dualism, and a hasty glance over his books, *From Immigrant to Inventor* and *The New Reformation*, tends to support the charge. He seems to mingle scientific fact with art, poetry and religion, but a closer reading shows his science is in line with the views of modern investigators, and he is careful to set apart from the realm of experimental knowledge his personal mystical speculations.

What are the life-stimulating rays that come from the stars? They were reported by Gockel in 1910 and three years later by Hess and Kolhorster. Quite recently they were intercepted on Pike's Peak, in soaring balloons, and in the depths of mountain lakes by the American physicist, Millikan, after whom they were popularly named. Six feet of lead these celestial super-rays penetrate, utterly dwarfing in comparison our earthly workshop products of X-rays, radium beams and the like.

And for the youth who landed at New York with a nickel the next night school was a boiler room



The starlit Hungarian plain was a night school for Pupin, Serbian boy herdsman

"We know all chemical action is preceded by ionization," said Pupin at a private conference during a recent annual meeting of the American Association for

the Advancement of Science. "We know, too, that Millikan rays strongly cause ionization. My suggestion is that their ionizing power furnishes a stimulating action in the living cells."

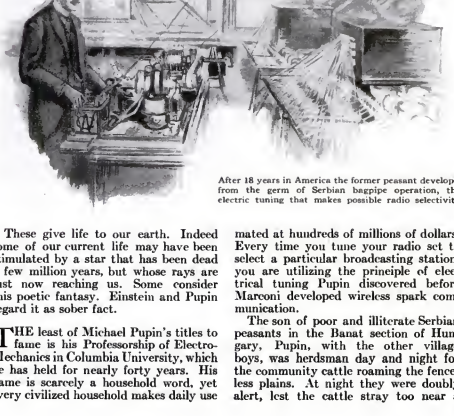
Ionization means, by the way, a temporary disturbance or dislocation of electrons from their usual orbits.

Pupin added modestly that the subject was out of his province, and that he had referred it to the biologists, who said they would be glad to experiment as soon as the rays were brought under control for handling.

How are the super-rays created? Either by the birth or death of matter in the atonic form. Each atom is a submicroscopic solar system with positive nucleus for its sun and a number of negative electric particles, electrons, revolving around the nucleus. These satellites are locked in their orbits with an inconceivable power. Tear them apart and away from their orbits, and the energy which tears them away will fly into space as radiation. This has been done in a laboratory. In the sun and stars, under terrific heat and pressure, endless myriads of atoms are torn down, wrecked, rebuilt, altered, destroyed, remodeled; and a vast amount of divine debris of creation consisting of trillions, quadrillions and yet more numerous hosts of energy corpuscles flies into space at a speed of 186,000 miles per second.

Now as a Columbia University professor he has become a world authority on mysterious electrical phenomena

Michael I. Pupin as he is today—who says science will never penetrate the veil beyond which divine power sits enthroned



After 18 years in America the former peasant develops, from the germ of Serbian bagpipe operation, the electric tuning that makes possible radio selectivity

These give life to our earth. Indeed some of our current life may have been stimulated by a star that has been dead a few million years, but whose rays are just now reaching us. Some consider this poetic fantasy. Einstein and Pupin regard it as sober fact.

THE least of Michael Pupin's titles to fame is his Professorship of Electro-Mechanics in Columbia University, which he has held for nearly forty years. His name is scarcely a household word, yet every civilized household makes daily use of his basic discoveries. Every time you telephone or send a telegram you avail yourself of an efficiency in transmission due to the "Pupin loading coil." The value of that invention to America alone has been estimated at hundreds of millions of dollars. Every time you tune your radio set to select a particular broadcasting station, you are utilizing the principle of electrical tuning Pupin discovered before Marconi developed wireless spark communication.

The son of poor and illiterate Serbian peasants in the Banat section of Hungary, Pupin, with the other village boys, was herdsman day and night for the community cattle roaming the fenceless plains. At night they were doubly alert, lest the cattle stray too near a Rumanian settlement and be stolen by cattle thieves. Lacking watches, they learned to tell time by the stars. Lacking means of communication for the guard line, they rigged up a sort of ground telegraph which some caveman probably first thought of. They thrust their long herdsmen's knives into the ground. By putting their ears to the handles they could hear the tread of cattle at some distance, the tapped signals of their comrades, and the approach of thieves. Michael noticed that his knife carried messages better through hard ground and that the vibrations were dampened by soft earth. So did the other boys, but it never meant much to them. The dark plains with the glittering stars overhead were indeed for him a night school in physics.

PUPIN came to America in 1874, an immigrant boy of fifteen. He did have five cents but squandered it on a pie. He was a queer looking young foreigner, when he arrived at Battery Park, New York. A crowd of newsies and bootblacks jeered him, pointing at his red fez. Then a big boy knocked it off. Michael punched his assailant's nose and they clinched. The immigrant won the contest and threw the bully. The others yelled and the Serbian feared a concerted attack, but they were merely cheering the victor. As he was seized by a policeman, the boys interceded and Michael walked off with his fez on his head.

Pupin thought himself a greenhorn. On his way through Philadelphia to a farm job he asked if this was the place where Benjamin Franklin flew his kite and brought electricity from the sky. He was rebuked for a silly question, since his informant had never heard of anybody named Franklin. (Continued on page 130)

Signs Painted On the Clouds

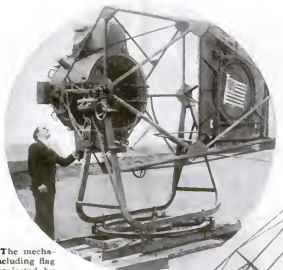
Four-Billion-Candlepower Beam from Huge Projector Promises to Make Whole Sky a Movie

GIGANTIC advertisements with letters 150 feet tall are now hurled across the sky above New York's "Great White Way" with a colossal four-billion-candlepower projecting engine—a device tamed from its wartime duty of sending blinding light against the crews of Zeppelins over London. So powerful is the beam that a display cast at one moment on a building across the way may at another be swung to a cloud or bank of heavy air two miles above Times Square.

Stencils on slides alone are used now, but motion pictures may soon cast figures into the heavens that will make pygmies of the giants of mythology.

H. Grindell-Matthews, British scientist, developed the projector, using a Sperry searchlight with an unusually heavy electric current and a superior carbon mixture for the arc. Current passing between the carbon pieces in the searchlight produces an intense light that is reflected by a concave mirror through the display stencil in the framework of the machine and on through the magnifying lens at the far end.

The biggest magic lantern extant, atop a New York building, casting light on a near-by skyscraper before swinging its beam to clouds two miles up. The machine, which blinded Zeppelin crews, now promises sky movies



Above: The mechanism, including flag stencil projected by the four-billion-candlepower light. **Below:** Major C. H. Biddlecombe ready to project a sign

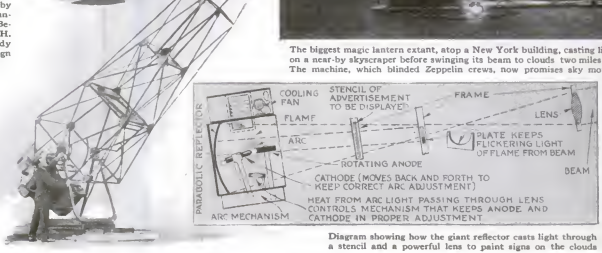
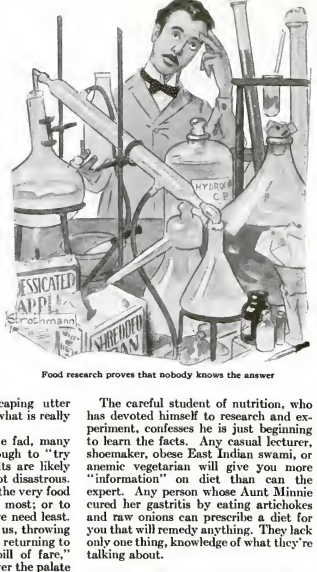


Diagram showing how the giant reflector casts light through a stencil and a powerful lens to paint signs on the clouds

What Doctors Don't Know About Diet

A Food Chemist Tells How Recent Research Explodes Pet Theories of Nutrition

By T. SWANN HARDING



Food research proves that nobody knows the answer

A MIDDLE-AGED man of my acquaintance, suffering from high blood pressure, called on his physician—a highly reputable practitioner—and after a thorough examination was told:

"My friend, your trouble comes from eating too much meat."

The patient heard the verdict in amused astonishment.

"Perhaps you're right, doctor," he said, "but I haven't touched meat for two years!"

The doctor attempted no excuses. Frankly he admitted error and then prescribed the advice most likely to be foolproof—that of avoiding emotional excitement.

That incident is not extraordinary. Possibly you have had some such experience. Millions of Americans, I venture to say, have at times attempted to follow explicitly equally absurd diet instructions from physicians or others. Indeed restricted diet appears to be a fad of the moment. Hundreds of self-styled authorities are handing us perfect bills of fare, listing things that are supposed to be good and bad for us. Quacks and faddists are promising to lead us to health, good looks, long life and prosperity by way of our gullets. Even some orthodox and conservative physicians are venturing, in all honesty, to dictate what shall go on our dinner tables.

WE ARE told to eat food raw, and also to eat it cooked; to eat fruits, and also to avoid them; and so on without end until he is a superman indeed who, escaping utter bewilderment, can find out what is really good to eat.

Still, to keep up with the fad, many are willing and gullible enough to "try anything once." The results are likely to prove disappointing, if not disastrous. For we are likely to give up the very food substances our bodies need most; or to stuff ourselves with foods we need least. Small wonder that many of us, throwing up our hands in despair, are returning to "the good old American bill of fare," eating whatever and whenever the palate dictates, regardless of results.

To get down to cases, this diet business, for the most part, is plain bunk, because no unalterable rules of eating can be made to apply to every one. In chemical make-up your body differs from that of every one else in the world.

"My friend, your trouble comes from eating too much meat," said the physician. "Perhaps you're right, doctor," said the patient, hearing this with amused astonishment, "but I haven't touched meat for two years!"

The careful student of nutrition, who has devoted himself to research and experiment, confesses he is just beginning to learn the facts. Any casual lecturer, shoemaker, obese East Indian swami, or anemic vegetarian will give you more "information" on diet than can the expert. Any person whose Aunt Minnie cured her gastritis by eating artichokes and raw onions can prescribe a diet for you that will remedy anything. They lack only one thing, knowledge of what they're talking about.

SIX years ago I knew nothing about nutrition, and could have informed you about it fluently. Now, having engaged in research work with some diligence, I am reduced to painful confessions of ignorance. I have simply got far enough to know that none of us knows the answer.

A friend of mine is a nutrition chemist. He does nothing else but investigate food problems—for other people. He began to feel ill and finally landed at Johns Hopkins. What was the verdict? "There's nothing the matter with you organically. But if you'll go home and eat less or exercise more—either one—you'll be all right." He did and is well.

If nutrition investigators cannot regulate their own eating satisfactorily, what hope is there for the quack-ridden layman? Alas, the scientific nutrition investigator knows little enough, but the public should be told that little.

From this humble standpoint we now can proceed at least to discover some of the things we specifically do *not* know to be true about

eating. We can knock in the head a number of the most common food fallacies, sort out certain authentic bits of useful information, and outline some of the broad general principles of nutrition. The instruments we shall use are the impartial results of competent research.

Imagine you feel "run down" and consult a doctor. Ten to one, he will advise you about diet, and among the first things he recommends will be milk and raw eggs.

Well, milk is *one* good food, but by no means a complete diet. It lacks iron and other important minerals, as well as the growth-promoting vitamin A and vitamin C, which prevents scurvy. It is too low in vitamin D to protect against rickets.

As for raw egg white, it is decidedly indigestible and ineffective in stimulating the flow of gastric juices and the secretion of bile. Of course, egg yolk is a valuable source of vitamins, but it is highly acid.

Now what of the popular interrogation: "Have you had your iron today?" The physiologist Bunge's idea that we must have iron from an organic source has long been in the museum of scientific antiquities, yet peptonized and other organic iron tonics still flood from manufacturer to pharmacist to gullet.

AS A matter of fact, the body uses iron most economically. In case of iron starvation it will use what it has over and over again. We need from six to sixteen milligrams a day—an insignificant amount when you consider that there are about 29,000 milligrams in an ounce. Any mixed diet supplies the sixteen. Two eggs, a few peas or prunes will do it. Raisins and molasses are good. Iron tonics supply enormously more than we need, taxing our bodies to eliminate it.

Now let us consider the vegetarians. Some years ago Chittenden, after extensive experiments at Yale with a very low protein diet, concluded much less meat protein should contribute considerably to American well being. But does this prove that man should be a vegetarian? The entire duration of Chittenden's experiments did not exceed one percent of the normal span of life. Is that long enough to warrant conclusions? Actually we do not know what effects a long continued vegetarian diet might have. As to the avowedly vegetarian higher ape, is his diet perhaps the cause of his low estate? Perhaps some ape became man when he began eating meat! That is fanciful, but it is quite as logical as the demand that man should restrict himself to fruits, nuts and cereals because the ape prefers them.

A vegetarian diet may be best for certain individuals but, speaking generally, it is difficult to assimilate enough protein on such a diet. The body cannot readily use vegetable proteins, and meat supplies the best available protein

Does this prove that man should be an absolute vegetarian?

supplement for a diet already adequate in green vegetation. Animals have thriven on diets containing as much as eighty percent of meat protein. It is true that rabbits fed on a high protein diet containing twenty percent meat showed increased blood pressure and excessive albumin, but rabbits are normally vegetarians and hence poor subjects for such a test. Even so, they survived this unnatural diet in perfect health if they ate green vegetation in abundance. Rats fed a two-thirds protein diet grew normally. If raised on a low protein diet they readily adjusted themselves to more protein when it was fed. Mother rats nursing litters weighed more and raised healthier young when fed meat in an adequately balanced diet than when meat was not fed.

We cannot conclude that vegetarian diet is best for man. It is doubtful if it is ever best save temporarily during some diseased condition, although an exception is to be noted below. Still, we do habitually tend to eat too much meat. Cutting down this over-consumption undoubtedly would help in preventing disease. It is unfortunate that the human race seeks to cure so many of its ills by oscillating from one inadvisable extreme to another.

VILHJALMUR STEFANSSON, the Arctic explorer, for instance, lived for nine years on an exclusive meat diet and examination thereafter proved him in perfect health. His examining physician at the same time reported two American patients who had lived for years entirely on meat without apparent detriment. The Eskimos themselves, exclusive meat eaters, are decidedly healthy until they change to our mixed dict, and have indigestion.

In a recent personal communication to me Stefansson speaks also of certain Asiatics who live exclusively on vegetables and are free from constipation. He adds that "it becomes interesting to inquire whether there is anywhere a community living on a mixed diet that is similarly free. Of course we must not conclude at once that it is the mere mixedness of the diet that causes the trouble."

These considerations at least indicate that heavy meat diets may have been castigated unduly and also that we know little definitely about human diet.

It might be well while we're at it to knock on the head the advice to "eat only one protein food at any meal." Proteins are built up of simpler substances called aminoacids. There are about twenty of these, and perhaps we need certain amounts of all. One protein very often will supply the aminoacids which another lacks. Hence combinations of proteins are just what we need to be sure of getting all the varieties.

Baby specialists today are advising bananas, once called indigestible, as ideal food for very young infants

ALMOST as silly is the "coarse food" fad—whole wheat, bran, fruit pulp—anything to keep the bowels functioning freely. True, bulk does have its use, but the theory is overemphasized. For one thing, coarse food particles tend to close rather than open the exit from the stomach, thus slowing down the digestive process. Walter O. Alvarez, of the Mayo Clinic, Rochester, Minn., says the surest way of helping the average dyspeptic is to take away his bran mash. Bran is the most indigestible substance in Nature. Except in cases of severe constipation, it should not be riotously indulged in.

"Avoid an acid diet" is another popular admonition, though there is no definite proof that a long continued acid diet is harmful. A tremendously abnormal acid-forming diet was *(Continued on page 116)*

Wing Slots Make Planes Safe

Demonstration plane in flight, showing slotted wings that send auxiliary air stream to ailerons to control balance. Above: Sir Samuel Hoare, British Air Secretary, in pilot's seat just before the test

Automatic Device, Operating When Motor Stalls, Prevents Disasters in the Air

By EDWIN KETCHUM

FIVE hundred feet above the Cricklewood, London, airdrome the other day, a huge fighter plane's motor coughed, sputtered, and ceased its steady drone. Experienced airmen, standing on the field, watched with horror as the big plane's nose went up in the air, robbing the slowing craft of its last mile of flying speed. By all accepted rules, only one thing could happen now, so near the ground—a swift, uncontrollable spin with no room to recover before the plane crashed.

But the plane, to their amazement, hung almost motionless in the air, then its nose dropped and it regained flying speed.

Automatic safety wing slots, latest invention to make aviation less hazardous, permitted this hitherto suicidal maneuver. They seem to banish the flyer's most deadly peril—the wild spin of a plane that has lost the speed it needs to keep aloft. Devised by F. Handley-Page, British aircraft builder, they are considered by some engineers the most important advance in aviation history.

When the plane circled to earth, Sir Samuel Hoare, British Air Secretary, stepped from the cockpit and praised the invention.

When a plane tilts upward, the wings lose their normal lift. They are standing on edge; and the air that passed over them before in a smooth, even stream is now a boiling, swirling eddy. The ailerons, the balancing flaps at the rear of the wings, cannot take hold. One wing dips. The plane spins and crashes.

By trapping a stream of air at this time and sending it backward over the tops of the wings, giving the ailerons something to grip, the new control slots avert such a catastrophe. They are inconspicuous, miniature seven-foot wings, so hinged to the main wings' upper surface as to leave narrow slots through which the auxiliary air stream is directed to the ailerons just behind.

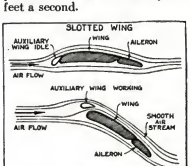
Marvels of control result. An airplane can roll over on a wing tip to perform half of a side loop; then, still on end, turn right or left at will. It can make a high speed turn on an absolutely even keel, an exceedingly dangerous maneuver at low altitude. And with a plane stalled in mid-air the safety slots enable the pilot to control his machine's rolling and pitching even when the tail slants downward.

In normal flight the wing slots do not operate, when the plane tilts so that normal control is lost the tiny curved planes commence work of their own accord, swinging outward on their metal hinges. The air pressure on the plane causes this action; the pilot is left free to handle his machine.

The brains of the automatic control is a wind gage, a U-shaped tube attached to a wing strut and facing forward. When the plane tips, the altered pressure on the tube, communicated through pipes to the cockpit, starts the mechanism that brings the wing slots into service.

A feature of the Cricklewood plane demonstration was a huge "incidence gage" with a pointer that indicated, on a graduated scale, the plane's tilt. It revealed that with aid of the wing slots the plane can practically stand on end, or start to do so. Above twenty-six degrees, the nose drops through the automatic restoring action of the slots and the plane recovers poise and control. It can even descend on even keel, nearly vertically, with power off at about twenty-five feet a second.

F. Handley-Page, inventor of slotted wing, hailed as the greatest advance in airplane building since the Wrights first flew, points out and explains his device to Sir Samuel Hoare before the test



Found! A Whole

By MYRON M. STEARNS

Drawings by Rutherford Boyd

EVERY time you put your foot on the earth, you step on hundreds of millions of your partners.

An entire microscopic world, with a population running into billions, lives and moves and multiplies in every shovelful of garden loam.

We used to think animals and insects and plants were the only living things in the world. Now science has discovered that under almost every square foot of ground are more living inhabitants than the entire human population of the globe! Living and working and multiplying for centuries before the forms we know as animals and plants ever appeared, they form a living world in themselves, upon which the larger forms of life developed. And new studies have revealed that without the work of the whole underground world, all the plants and animals we know about would quickly die—and so would we!

They would starve to death because they could not get any food they could digest. Without the work of the tiny citizens of the soil as butchers and chefs, the plants would be as helpless as a starving man with a dead rabbit strapped to his stomach.

This whole marvelous new field of knowledge, which is changing our understanding of man's entire relationship to the world about him, is so important that the First International Congress of Soil Science was recently held in Washington, D.C., with foremost scientists of all the great nations attending, and with one of America's leading soil scientists, Dr. Jacob G. Lipman, as president. It received no headlines in newspapers, yet it dealt with a subject so important that the slightest change in balance, the least disturbance of Nature's equilibrium, may bankrupt nations, change the history of races, or cause the death of untold millions of human beings through disease in a single year!

To learn more of this astonishing world beneath our feet for the readers of POPULAR SCIENCE MONTHLY, I went to see Dr. Lipman at New Brunswick, where he presides as Dean of the New Jersey Agricultural College of Rutgers University.

"The reason we have not known before of these underground citizens," Dr. Lipman told me, "is that they are so minute they can be studied only with powerful microscopes."

One little fellow, the Bacterium anthracis, and shaped something like a diminutive finger, is about one twenty-five thousandth of an inch wide, and nearly one five thousandth of an inch long! He is one of the giants! One of his really small cousins, belonging to a numerous family called micrococcus, is only one and a quarter millionths of an inch through. Forty thousand could march abreast through the eye of a fine needle.

"Even after microscopes had come into general use," Dr. Lipman explained, "for decades nobody suspected that minute plants and animals did work on which all larger life was dependent. Then, about the middle of the last century, Louis Pasteur discovered them. Since then much has been learned of the workers in the soil, but most of the whole new world is still unexplored.

"The whole underground world of life is made possible by the formation of the ground. Soil is made up of solid particles of mineral matter, and *the space between these particles.* This space, when dry, is known as 'pore space.'

"Microörganisms can't live in solid rock or metal. They have to have room, and moisture, and air. All these are found between the solid particles in the soil."

In a pile of big rocks, there's a lot of space in the chinks; it's the same way with soil.

"The 'pore space' between the solid mineral particles," he went on, "varies from perhaps one third of the total volume, as in coarse sand, to as much as two thirds in silt or fine loam or clay. In peat or muck it is sometimes eighty or ninety percent."

This was surprising! The smaller the particles of solid matter, the greater is the proportion of 'pore space.'

Two scientists named Lyon and Fippin set out to count the mineral particles in a small amount of soil—one gram. In a gram of gravel they found 252 particles; in fairly coarse sand, more than 13,500. And with finer materials they had to count a small portion and estimate the total. There are 65,100,000 particles in a gram of silt, and 45,500,000,000 in pipe clay!

"But what of the moisture necessary for the life of the soil population?" I asked and learned of another one of Nature's astonishing provisions.

Lyon and Fippin measured and found that even in "air-dry" sand like that of the Arizona desert there is from one half to one percent of water! In "air-dry" silt, two to four percent! And in clay, eight to twelve percent!

"Around each mineral particle," said Dr. Lipman, "is a film of moisture known as 'hygroscopic water.' This film in even seemingly dry soil is about three one hundred thousandths of an inch thick."

We are accustomed to think of the world on which we live as a great planet, but small and insignificant compared to the hundreds of thousands of stars in the sky—each of them

What a powerful enough glass would show in any handful of earth—millions of organisms that renew very life of the world

New World under Our Feet

Powerful Microscopes Reveal Strange Animals and Plants in the Soil; So Small That Millions Could Rest on Your Finger Nail and Yet So Energetic That They Feed Us All

mighty suns, incomparably larger than our earth, so large that we yet know as little of it as the cricket along a railroad track knows of the mechanics of a locomotive. But here we have the reverse of that picture—a complete world on the surface of each particle of fine loam or silt, so small that you can pile millions of them on your finger nail!

"When water from the air, or rainfall," Dr. Lipman explained, "is added to this hygroscopic moisture it rapidly expands, until the pore space of the soil turns into a teeming world of life."

But that is not all. Most of the soil population need air, and the passage of air through soil has been measured.

"About 5000 cubic centimeters of air was observed to pass through a column of gravel in thirty-seven seconds," said Dr. Lipman. "Under the same conditions it took 1178 seconds for the same amount of air to pass through ordinary sand, 44,310 seconds, through fine sand; 282,900 seconds, through loam, and 2,057,000 seconds through pipe clay."

At low temperatures most of the underground citizens become thick skinned and dormant; they are killed by great heat. But at around sixty degrees Fahrenheit—and in the ease of some species far below that—they perk up and multiply, up to well above a hundred degrees they thrive mightily.

"When the balance of air, moisture, and temperature is right," said Dr. Lipman, "the soil population flourishes, and life becomes possible for the larger plants and animals that we know. When the balance is not right, the soil population dies off, and life as we know it dies off with it."

Too much moisture limits the oxygen in the pore spaces, and the soil citizens that require air begin to lose out; excessive moisture also breeds too many of their enemies; so the balance of power is disturbed. In air-dry soils like desert sand, the water is too limited; they can live only in the limited space of the hygroscopic moisture film. Under these conditions many varieties go into a dormant state in which they can survive for long periods—even years. When the necessary balance is secured again, they take up once more the burden of existence.

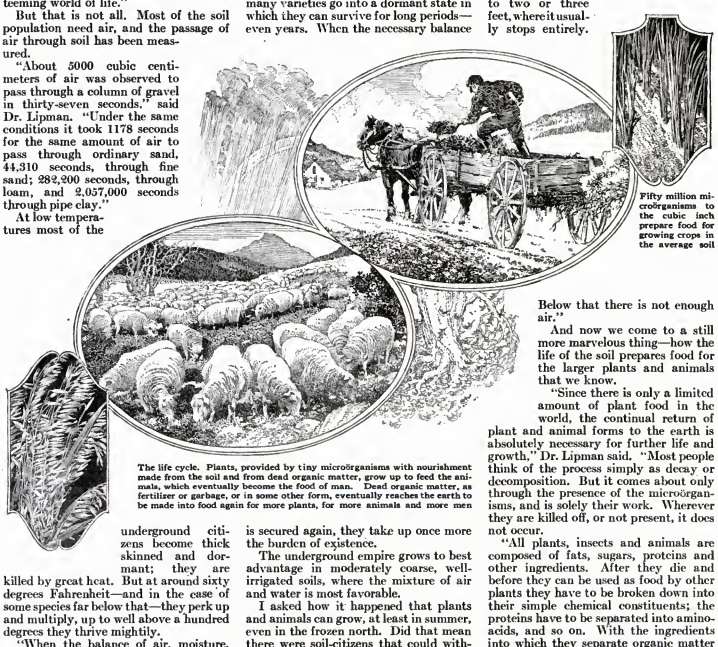
The underground empire grows to best advantage in moderately coarse, well-irrigated soils, where the mixture of air and water is most favorable.

I asked how it happened that plants and animals can grow, at least in summer, even in the frozen north. Did that mean there were soil-citizens that could withstand great cold?

The soil census shows a wide range. In newly-broken peat, like that of a Minnesota bog, the population may be scanty—650,000 to each cubic inch! In well-tilled and cultivated soils, such as are found around New Brunswick, it runs up to 100,000,000 or more.

"How deep underground do these soil creatures live?" I asked.

"Most of them live pretty near the surface. The first half inch or so is not so popular, because it dries out too fast, but after that the number increases rapidly down to seven or eight inches, where it is greatest. Then it diminishes again down to two or three feet, where it usually stops entirely.



Fifty million microörganisms to the cubic inch prepare food for growing crops in the average soil

The life cycle. Plants, provided by tiny microörganisms with nourishment made from the soil and from dead organic matter, grow up to feed the animals, which eventually become the food of man. Dead organic matter, as fertilizer or garbage, or in some other form, eventually reaches the earth to be made into food again for more plants, for more animals and more men

Below that there is not enough air."

And now we come to a still more marvelous thing—how the life of the soil prepares food for the larger plants and animals that we know.

"Since there is only a limited amount of plant food in the world, the continual return of plant and animal forms to the earth is absolutely necessary for further life and growth," Dr. Lipman said. "Most people think of the process simply as decay or decomposition. But it comes about only through the presence of the microörganisms, and is solely their work. Wherever they are killed off, or not present, it does not occur.

"All plants, insects and animals are composed of fats, sugars, proteins and other ingredients. After they die and before they can be used as food by other plants they have to be broken down into their simple chemical constituents; the proteins have to be separated into amino-acids, and so on. With the ingredients into which they separate organic matter the microörganisms mix various necessary minerals from the particles of the soil.

"Every dried (*Continued on page 122*

On the way to the front to chase Big Bertha. One of the Navy's big guns, weighing with its car 267 tons, crossing a temporary wooden trestle in France. A single shot from such a gun drove the Germans from Tergnier and the French walked in

Big Guns in France

Despite Skeptics, Navy Goes into Action on the French Front, and Giant Weapons Take a Town with a Single Shot

By REAR ADMIRAL CHARLES P. PLUNKETT, U. S. N.
In Collaboration with THOMAS M. JOHNSON

ST. NAZAIRE was the port selected for us because it had a 150-ton crane at one dock and two 125-ton cranes at French locomotive shops, with the Montoir storehouses near by. But when we got there we found plenty of chance for Navy ingenuity.

The barracks they wanted us to sleep in were full of potatoes, and the floor had sagged. The 19th Engineers, all railroad shop men, were unloading and assembling locomotives. Some gob was heard to remark, "That's pretty good lumber those engines come packed in." Right away we set to work making barracks, beds and all, out of locomotive packing cases.

We had to re-lay the tracks to stand the weight of the gun car. To erect that car we would need compressed air, so we salvaged an old stationary boiler, patched it up, overhauled a leaky air pipe line, and were all set.

But when the first shipload of material came in, all we could do was store it, for there was practically no complete unit.

WHILE waiting, some of our mechanics went to help at the roundhouse, others aided the 19th Engineers to assemble locomotives, and still others organized switching crews, manned locomotives, and helped clear up the yards. When we were ready to start erection the Engineers lent us one of their thirty-five-ton steam cranes.

But the battle of St. Nazaire had to be fought without a plan. We had no blueprints! A complete set of them, showing the assembly of every car, had been mailed from the United States, but it never arrived.

"Now It Can Be Told"

Admiral Plunkett, who commanded the Navy's big guns that outshot "Big Bertha" and drove her from the field, reaches a thrilling climax in this, the second of his amazing stories of the American "Battleships on Wheels," one of the most dramatic incidents of the great war.

All those gobs we had sent to the Baldwin Locomotive Works and the Standard Steel Car Works had kept notebooks, sketching details of construction, parts and assembly. Time after time, as we put together what seemed like a gigantic jig-saw puzzle, somebody's notebook would show us where something went or how to put it there.

The heaviest single job was lifting the gun girder from ship to shore. The 150-ton crane was run by a somewhat antiquated Frenchman whom impatient gobs suspected of being a German agent—he certainly seemed to be delaying the war. His crane was not brand-new, and it was a heavy lift, but it was miraculous how often it broke down and how a fifty-franc note seemed to facilitate repairs. It seems to me I had to climb up on that crane and give first aid, so to speak, at least once a day until all our stuff was ashore.

American sailors inside an ammunition car of a "battleship on wheels." The picture shows the machinery used to move the 1400-pound shells, 22 of which destroyed a German ammunition dump

UNLOADING the big gun was a problem, for it would crush the light French flat cars. We solved it by first unloading the trucks, then putting the gun girder on them, next inserting deck lugs and gun slide, and finally unloading the gun on the girder and taking the whole thing to outside erecting tracks for completion. Here we assembled the cars also, first trucks, then frames, sides and roofs, and lastly interior fittings.

That was harder than it sounds, for when we opened the packages marked "rivets," we found them full of stove bolts!

We had to put together seventy-two cars, each of which needed to hold it together between 500 and 1200 rivets. Well, we just started out and "borrowed" rivets all over France.

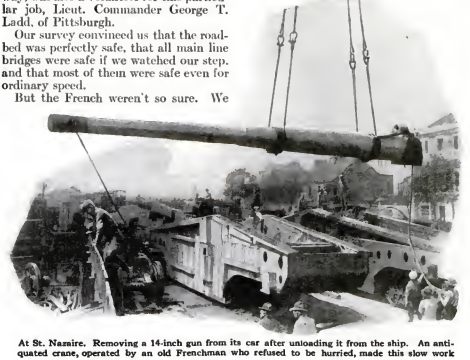
Those gobs had shown themselves able to get cranes from hard-boiled American railroad men and had even taken the headlight off a French locomotive in broad daylight. In a few days we had rivets, of all shapes and sizes, but all based on the metric system. Our mechanics drew the large ones down to the proper size by hand. For days afterward the mayor of St. Nazaire brought all his friends down to see the *marins américains* tossing red-hot French rivets to one another as they put together their cars.

WE WERE getting along pretty fast, and the people of St. Nazaire were beginning to take interest. They saw our great long guns being mounted on our battleships on wheels, and they never had much doubt of our ability to deliver the goods, but there were others who had. They were the French and American "experts" on ordnance. Of two such American experts, one had been a clerk in a drug store (he was a Major); the other had trained for war by supervising important stamp-licking activities in a Southern city hall. They, and others who knew rather more about ordnance, were sure the French railroads wouldn't carry the gun car, and as for the bridges, they would collapse from sheer fright when they saw us coming. American railroads were one thing, they said, French railroads another. The latter had been built for toy 40 hommes, 8 chevaux boxcars that were pushed around the yards by hand (they really were) and were run down after four war years. But we sailors didn't believe the experts.

We did some land scouting by automobile. Commander Garret L. Schuyler and I were accompanied by Lieut. Commander Dexter C. Buell, now of Omaha, Nebr., one of our first volunteers. He had been visiting in Washington when the contracts were let, and had walked into the Ordnance Bureau and said he'd like to go along. A fine railroad man, he first handled the job of material inspection in the States, then bossed assembly in France. His assistant at home, by the way, was also a volunteer for this particular job, Lieut. Commander George T. Ladd, of Pittsburgh.

Our survey convinced us that the roadbed was perfectly safe, that all main line bridges were safe if we watched our step, and that most of them were safe even for ordinary speed.

But the French weren't so sure. We could shut up the drug store ordnance experts, but our Allies allowed those were the only railroads and bridges they had with which to fight the war, and they didn't want them wrecked. They sent Captain Debonett, a French artillery constructor who in civil life was a bridge engineer, to find out all about our old favorite, axle-load. He reported the bridges safe, but he would bet no francs on the roadbed standing up. We put two and two together and decided that if we were sure of the track and he of the bridges, there would be no trouble.



At St. Nazaire. Removing a 14-inch gun from its car after unloading it from the ship. An antiquated crane, operated by an old Frenchman who refused to be hurried, made this slow work

WE TOLD that to General Pershing, when he came to see us while assembly was going on, and he was much pleased, for some of the reverberations of the battle of St. Nazaire had reached his G. H. Q. at Chaumont, clear across France. The General had believed in us from the start, and was much interested to see the guns he had sent for. Although immaculate, as he always was, he climbed up onto a gun car while I explained the construction. Then who should appear but Commander Buell—with a long black cigar! A good railroad man—but he hadn't been a Naval officer very long. Somehow I got between him and General Pershing, and landed a quick kick on Buell's shins.

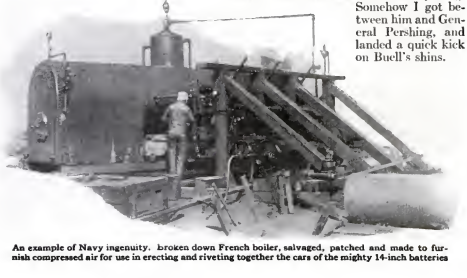
"Throw away that cigar," I whispered in his ear—and he did. Then I presented him to the General.

Thus the Army and the Navy continued to coöperate—and the war was won.

General Pershing told me that day that the American Army would soon be assembled as an independent command, and that as soon as it was he hoped our Naval guns would be attached to it and work under his own direction. Meantime we were to be under orders of Marshal Foch, to go anywhere he might order—wherever the fighting was heavy and the need great.

The first job the French had for us was to knock out the Berthas that were shelling Paris, or at least force them back so far that they could not reach the French capital. They were in a hurry about that, and we got one call after another to send forward two guns and trains as quickly as possible. Delay the others if necessary, the order was, but get two going.

We rearranged our original schedule for assembling all five guns and trains, and concentrated on two. We were all working under great pressure. The men were supposed to work from 7:30 A.M. until 5:15 P.M., with an hour off for lunch, but they refused to quit until it was too dark to see—almost ten o'clock. But for the men we could not have made the record we did in assembling the batteries.



An example of Navy ingenuity. Broken down French boiler, salvaged, patched and made to furnish compressed air for use in erecting and riveting together the cars of the mighty 14-inch batteries

THE first gun girder was unloaded from ship July 30. August 11 we had the completed gun car and first train ready to leave for the front. Everybody was on edge to go. We wired the French High Command—"All set. Where do you want us?" We waited. Then came a telegram, "Don't come yet. Await further orders."

That was a hard blow.

It was August 18 before we finally pushed off with Train No. 1, and next day Train No. 2 followed. Franklin D. Roosevelt, then Assistant Secretary of the Navy, inspected the guns and mounts before we started. I had been skipping about from place to place, seeing French

Sailor turned soldier. Rear Admiral Plunkett, who commanded battleships on wheels

generals and American "experts," but I went with those two guns myself. This was what I had been dreaming of ever since I got the job—going into action as commander of battleships on wheels.

Our destination was Helles-Mouchy, about halfway between Paris and Amiens, and over 350 miles from St. Nazaire, and we had to pass over three railroad systems, the Orleans, Etat and Nord—a good "trial trip," if we needed one.

It was certainly the most thrilling railroad journey I ever made, although we never went faster than six miles an hour. We were sure we could go faster, but respect for the nerves of the French and the drug store ordnance experts constrained us. Our trip was a sort of triumphal progress. We didn't try to hide the guns, for we thought a look at them would do more to raise French morale than anything we could think up. Also, we were rather proud, you know, of having put it over and being at last on the way to the front, after all delays and mishaps. We were to find it wasn't as simple as that.

WHEREVER we appeared, a crowd gathered. French soldiers, old men and women and children in wooden sabots stared and exclaimed, "Oo! La! La!" Word that the train was coming was flashed ahead, and at our sedate speed there was plenty of time for a crowd to gather at each station. Many people had flowers and wreaths to decorate the guns. Some of the wreaths were too small to go over the great muzzles—and everybody laughed and cheered some more. Then we would glide slowly and majestically away for the next ovation.

Sometimes that would be from American soldiers filling troop trains that we passed. How they did cheer! And when they heard our whistle and bell, they cheered again. "Ring that bell!" they would chant, "it sounds like home!" And we would ring the bell again and blow the whistle that sounded like a foghorn compared to the "toot-toot" of the French engines.

I don't think our French pilots enjoyed the trip quite so much. They had the axle-load complex, and Commander Buell and I, in the cab, had to calm them down when we came to a bridge. They didn't understand the air brake, either, and were always shouting "*Doucement! Doucement!*" which means slow down, when we came into yards. But we let them start the train according to their regulations, which are that the conductor must blow his whistle to show he is ready, and the station master blow a horn to show it is all right with him, before the train can leave. The gobs used to jump off and try to steal a horn so as to save time at

Covering a gun for camouflage after firing a shot in the Meuse-Argonne battle, in which the Navy's guns, which some "experts" said would never reach the front, hastened the conclusion of the war

the rest of the stations we were to pass.

By the time Battery No. 1 reached Helles-Mouchy at 8:30 P.M., August 23, the whole of France must have known that the biggest guns that had ever been in the country were on their way to the front. It had taken us nearly a week to get there, but there we were. We had gone through Paris, but underground, by the subterranean tracks of the Ceinture, the circular belt line connecting all the railroads that enter the city. In that labyrinth we encountered a Minotaur in the shape of a French railroad official who crawled under our locomotive and triumphantly discovered that certain nuts and bolts (probably French) hung down so low that they would foul some special fittings in the tunnel. He started a lengthy address about why we should go back, and before he got through we had cut off all the protruding bolts with oxy-acetylene. Then we went on.

But we couldn't satisfy one French station master so easily. When we started the French gave us a railroad map with all the unsafe bridges marked in red ink. Then they routed us across one of those bridges. When we reached the next station, the *Chef de gare* was horrified. *Nom de Dieu*, he said, we had been routed wrong. The only way to remove the official mistake from the record was to go back *over the same bridge* and come around another way. Well, we did.

OUR crew really saved us from getting stuck by hot boxes. The bearings ran hot, and we had to creep into sidings pretty often to cool off and repack. We got along at all only because some of our railroaders recruited from the Baldwin Works rode along hanging just clear of the roadbed, where they could feel the bearings' pulse and feed them oil through a rubber tube made by cutting up a tourniquet from a first aid package.

They would lie for hours in a sort of improvised rope hammock swinging over the car side, and when they got out would be aching and stiff and sore. You couldn't order men to do that, but these men insisted on doing it.

Oh well, *c'est la guerre*, as we were learning to say, and at last we were at Helles-Mouchy, a regular headquarters of the French General Reserve Artillery, of which we were temporarily a part. I had made an earlier visit there and now I supposed all was ready for our first shots at the Berthas. But I had forgotten our luck.

The French artillery officers had good news, they said, great news. The long-range German bombardment of Paris had stopped. The Berthas had been withdrawn. That was what they called great news!

Of course, we hated to break that to the gobs. It seemed pretty tough after all their work. But in a few minutes they recovered.

"No wonder, with all the fuss we made on the way," they said. "The Germans heard we were coming, and skipped out."

The Navy believes to this day that is what stopped the bombardment of Paris.

THE Germans were certainly interested in us. As soon as we approached Helles-Mouchy their airplanes were snooping over us. The French were in a hurry for us to get tarpaulins over the gun, and while our men were at work shrapnel fired from French antiaircraft guns to chase the Germans away fell near them. Some of their first real war souvenirs were bits of shell fragment and shrapnel picked out of the ties. This region was an important railway center, just behind the front, and the towns, especially Creil, were badly bombed. There were air raids every clear night, and we began to get the real feel of the war.

But once more we were all dressed up and no place to go. The French were still cagey about our guns. We had proved we wouldn't wreck railroads nor bridges, now they wanted to know whether we would wreck the Germans. They wanted us to fire a few *(Continued on page 150)*

Exit—the Torch Burglar

How new vault doors of copper defy the most successful of all bank criminals

By ALLAN O'HARA

Burning through a two-inch steel plate in seventeen seconds with oxy-acetylene torch—a test revealing the vulnerability of bank vault steel

The torch test that proved the impenetrability of the new vault door. Note, on the small frame at the right, a section of cast iron vault plate which has been pierced by the torch

"IT'S a flop," cried "Wabash Whitey," veteran torch burglar. Glancing at the clock over the bank door he saw that it was nearly four A.M. Dawn was approaching. Early risers were beginning to appear on the streets of the small Indiana town. It was no time to be trying to burn a way into a bank vault.

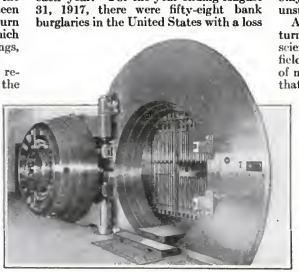
Beaten, "Whitey" threw down the oxy-acetylene torch. The gas drum was empty; all the torch tips had been burned away; the rest of the gang were fidgety. For three hours they had been taking turns at the torch, but its jet of blue and white flame had only half penetrated the massive metal door. "Whitey" pulled off his welder's helmet and threw it on the floor.

"They're using some new dope in that door," he complained. "It's got us licked. Beat it!"

The five burglars climbed out through a rear window and dissolved into the shadows. It was the first time in fifteen years that "Whitey" had failed to burn his way into a vault, and this vault, which spelled his Waterloo, offered rich pickings, some $100,000 in cash and securities.

This incident, reconstructed from reports of detectives who investigated the unsuccessful foray, tells the story of metallurgical science's recent decisive triumph over the most successful of bank criminals. Ever since the torch was invented the burglar has been using it. Long ago he abandoned drills and explosives. He found it easy to steal torches and gas from railroad yards and construction jobs. Taking advantage of each improvement in the torch, he overcame each newly devised method of vault construction. He defied science to build a vault he could not penetrate.

The greatest sufferers were the banks. Five eighths of the world's banked wealth, or $52,000,000,000, is deposited in financial citadels of America. Since the war, vault building in American banks has increased 500 percent, due to increased interest in security buying. Yet vaults were becoming less impregnable each year. For the year ending August 31, 1917, there were fifty-eight bank burglaries in the United States with a loss of $100,000, and also fifty-seven unsuccessful attempts. During the year ending August 31, 1927, eighty-three burglaries were perpetrated and the loss was $185,000—almost double what it had been ten years earlier. More significant, only forty-three burglary attempts were unsuccessful.



The burglar-proof door swung open. The scout of the bank burglar "mob" knows that this is one of those new things he can't get into and advises his fellows to keep away from it

Alarmed, organized banking interests turned to the scientists for help. And science, instead of searching unexplored fields, turned to one of the world's oldest of metals—copper—and found the secret that it was looking for.

It was copper that "Whitey's" torch encountered and that sent him and his gang scrambling out the bank window, licked!

The discovery that copper would turn the trick came about in 1927 in an unusual way. A metallurgist who had been specializing on metal vault construction was motoring through France. His car broke down in a small French village and he lodged for the night in a peasant's cottage. He observed that the housewife, preparing dinner, made sparing use of fuel. With a bellows she was able to fan a smoldering log into a blaze (*Continued on page 118*)

Many eminent men believe in telepathy, either as a possibility or a demonstrated fact; yet thousands of tests in all parts of the world leave the majority of scientists still unconvinced, even despite the amazing successes reported

Is Telepathy All Bunk?

What Scientists Have Discovered About This Widely Discussed Subject in Thousands of Exhaustive Tests

By KENNETH WILCOX PAYNE

WHILE American engineers were perfecting trans-Atlantic telephony by radio, an engineer in Paris was attempting a still more marvelous communication. He was trying to send messages to persons in New York without any physical apparatus at all, but by the direct action of mind on mind—by telepathy.

He now reports seven successes out of twenty-two experiments. Various ideas, such as the mental picture of a loving cup with handles shaped like antlers, have been intensively visualized in Paris and simultaneously perceived, so we are told, by persons of telepathic powers in America.

THE organizer of this experiment is René Warcollier, a chemical engineer of standing. In New York he has had the collaboration of Dr. Gardner Murphy, psychologist of Columbia University and one of the three best informed students of telepathy in this country. Warcollier has gathered together twenty-five persons who, he says, can send and receive thoughts over long distances. Dr. Murphy has discovered six Americans who can do the same thing—or seem to.

But Warcollier considers telepathy established as a power in human nature; while Murphy, after three years' exhaustive experiment, considers nothing proved.

At the recent psychical research congress in Paris, Dr. Charles Richet, eminent physiologist of the University of Paris, testified to the truth of telepathy. Dr. Karl Krall, of Munich, declared he could by telepathy teach horses to do complicated mathematical problems. Professor Ferdinando Cazzamali, of the University of Milan, explained how he had actually taken photographs of "brain waves" that carry thoughts from one mind to another.

TEN or a dozen European scientists are convinced of such marvels. Among them are Baron von Schrenck Notzing, Professor Frederick Meyers of Cambridge, Sir Oliver Lodge and the Russians, Behterev and Chakhovsky.

But there isn't an American scientist of repute who will go so far. Which group shall we follow? What is the scientific status of telepathy today?

Most of us half believe in it because of personal experiences. The simplest and most familiar is the feeling of being stared at. If we credit that "sixth sense" as a fact—if we believe another person can compel us to look around merely by concentrating his mind upon us—then by admitting telepathy in its simplest form we are breaking through the established principles of physics, biology and psychology; consequently, there are no obstacles left to our believing in stranger forms of thought transference, such as clairvoyance and communications from the dead.

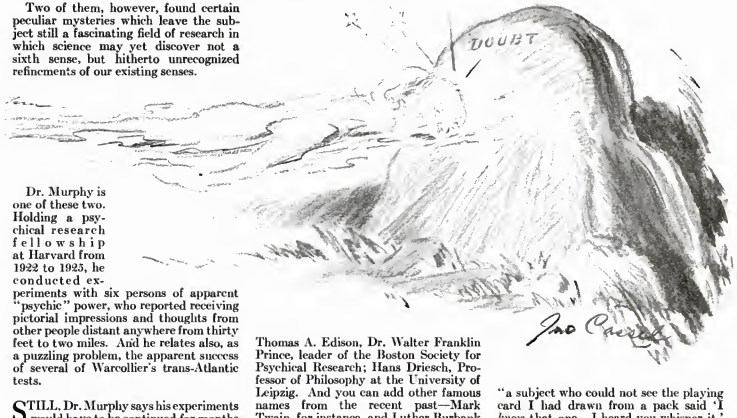
The great English pioneer in psychical research, Sir William Barrett, predicted the time when spoken language would be out of date, and human souls would constantly communicate by telepathy alone.

But even the simplest form of telepathy has not been established. Dr. John E. Coover, psychologist of Leland Stanford, Jr., University, put 900 students, all of whom believed themselves susceptible to this sensation of being stared at, through 14,500 experiments, which proved them wrong.

Whenever you raise your head to find somebody looking at you intently, you may be sure, on the basis of laboratory investigation, that it is due either to coincidence or to knowledge that has come to you—perhaps unconsciously—through your everyday five senses.

LIKEWISE, laboratory attempts to demonstrate more complicated forms of telepathy have had negative results. Besides Dr. Coover, five American psychologists in the past decade have given telepathy a chance to prove its powers, and none of them has found anything conclusive in its favor.

Two of them, however, found certain peculiar mysteries which leave the subject still a fascinating field of research in which science may yet discover not a sixth sense, but hitherto unrecognized refinements of our existing senses.



Dr. Murphy is one of these two. Holding a psychical research fellowship at Harvard from 1922 to 1925, he conducted experiments with six persons of apparent "psychic" power, who reported receiving pictorial impressions and thoughts from other people distant anywhere from thirty feet to two miles. And he relates also, as a puzzling problem, the apparent success of several of Warcollier's trans-Atlantic tests.

STILL, Dr. Murphy says his experiments would have to be continued for months before anything could be proved, and one principle of scientific research must be kept clearly in mind.

This principle is stated by Professor Carl Murchison, head of the department of psychology at Clark University, where last year the first symposium on psychical research ever organized by an American college was attended by some of the world's leading authorities.

"In all fields of science," says Professor Murchison, "the results of any careful experiment can be duplicated anywhere in the world by equally competent investigators. This is not the case in psychic research. Until results can be duplicated by others, the scientific world will have nothing but skepticism for the claims of psychic researchers."

Twelve of the foremost psychologists in America have expressed the same view to me in the last month. The point, then, is essentially this:

WHENEVER scientists or inventors perfect something new, like radio, its results can be observed and reproduced by anybody with adequate study. A ten-year-old boy can make a radio set. But Warcollier's experiments in trans-Atlantic telepathy cannot be regularly reproduced or observed even by himself. With fifteen failures to seven successes, the hypothesis of coincidence is more easily accepted by science than the hypothesis of telepathy, against which so many known facts throw their weight.

"But," say the psychical researchers, "the evidence for telepathy rests on thousands of cases reliably reported during the last forty years. The evidence is strong enough to have convinced many very distinguished persons, among them Professor William McDougall, of Duke University; Margaret Deland, the American author; Thomas A. Edison, Dr. Walter Franklin Prince, leader of the Boston Society for Psychical Research; Hans Driesch, Professor of Philosophy at the University of Leipzig. And you can add other famous names from the recent past—Mark Twain, for instance, and Luther Burbank and William James, the Harvard psychologist."

Then the only question is how significant we may consider the types of evidence which have swayed these brilliant minds.

They have been won over either by, first, some personal experience; secondly, the study of collected cases as published in many books; thirdly, the demonstrations of professional mind readers; or, fourthly, their interpretation of results in laboratory experiments.

LATELY I have gone over these four types of evidence with Dr. G. H. Estabrooks, of the Psychology Department at Colgate University, considered to know more about telepathy than anyone else in America.

As to the first type, he points out that we are so frequently deceived in our observation and understanding of personal experiences as to make any case of the kind practically worthless to science. For instance, a thought pops into my mind at the same moment my wife utters it. "Telepathy!" I exclaim. "But," says Dr. Estabrooks, "it may have been coincidence. Or your mind may have been following the same silent chain of association from a previous incident that your wife's mind was following.

"For instance," Dr. Estabrooks added, "a subject who could not see the playing card I had drawn from a pack said 'I *know* that one. I heard you whisper it.' Yet I would have sworn I hadn't whispered anything. Twice during my experiments I was heard to whisper. I did it unconsciously.

"Investigation proved that the famous Elberfeld horses in Germany, which showed wonderful intelligence that was credited to telepathy, reacted to minute, and probably unconscious, signals from their trainer. Human beings show similar keenness. Ordinarily we have no idea of how acute our senses really are. Once I distinctly heard a card drop to the floor in another room behind a double door. Sight and smell as well as hearing are constantly bringing us faint impressions that guide us without our knowing it."

Thus, self-deception and poor observation of details, on the one hand, and hyperaesthesia (or extreme sensitiveness to normal stimuli) on the other hand, are considered by the psychologist to explain the majority of personal experiences which we like to call "telepathic."

HERE'S a thoroughly typical instance. Sir Edmund Hornby, formerly Chief Judge of the Consular Supreme Court for China and Japan, has described in circumstantial detail how a Shanghai newspaperman appeared at one o'clock in the morning at the judge's bedside. The judge mentions his wife as having been present; and he declares that he learned next morning that the newspaperman was dying in another part of the city at the very moment his spirit appeared beside the judge.

Now Dr. Coover reports the following analysis of this evidence. First, the newspaperman is shown by official records to have died between eight and nine in the morning; secondly, Sir Edmund Hornby was not married at the time of the experience.

And in (*Continued on page 119*)

What Was Your Experience?

You have read what eminent men, some of them scientists, think of telepathy. You have read of tests and experiences. What do you think? What personal experiences have you had? For the best letter of not more than four hundred words received by February 15, this magazine will pay $25; for the next best, $15; and for the third, $5. Letters should be addressed, "Telepathy," *POPULAR SCIENCE MONTHLY*, 250 Fourth Avenue, New York City.

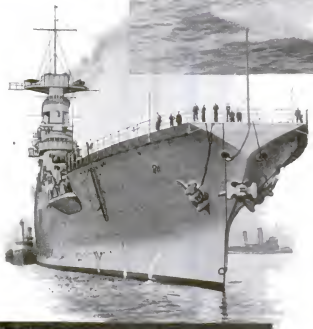
Shipbuilding Marvels That Mark New Era

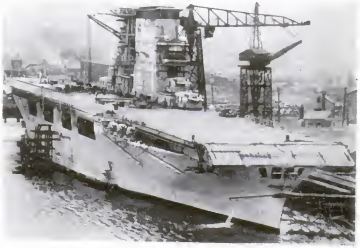
Navy Monster

Below is shown the largest ship ever built in America, the airplane carrier *Saratoga*, recently launched. It can carry 83 planes. Its top deck, obstruction-free for landing and starting, is nearly 900 feet long

Mile-a-Minute Boat

Speed records for load-carrying power boats are shattered by a new type of craft, tested recently at New York. An odd fin at its stern enabled it to better a sixty-mile clip with twenty-four passengers. The "fan tail" enables it to breast the water aquaplane style





Guards Atlantic While Sister Ship Cruises Pacific

The newly launched aircraft carrier *Lexington*, twin of the *Saratoga*, which is now virtually ready for service. Both vessels are all-electric in operation

World's Largest Submarine Is Launched

America's first mine-laying sub, the *V-4*, takes the water at the Portsmouth, N. H., Navy Yard. She carries eighty-eight men. Electric cooking, movies, and post office are among features for the comfort and amusement of the sub's crew

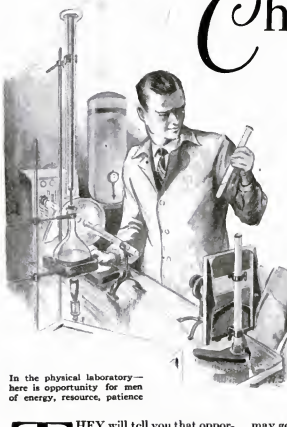
A Nonsinkable Boat

Safety in the event of collision is claimed for his remarkable craft by Adam Dretkolias, who recently tested the first full-sized model, seen above, at New York. Telescoping metal chambers, shown at right, expand and make the ship buoyant. The lowest one releases a gas that is fire-extinguishing

Chances to Get Rich Never So Great

Here Are Things the World Says Can Be Done, and It Is Ready and Eager to Pay You Millions if You Can Only Do Them

By HENRY SMITH WILLIAMS



In the physical laboratory — here is opportunity for men of energy, resource, patience

THEY will tell you that opportunity knocks once only at any man's door. Don't let them fool you. Opportunity knocks every day at all our doors. But most of us are too deaf to hear. Or if we hear, we fail to understand.

Did you hear the static crackling last night, when you had your radio tuned-in on that concert? At times you couldn't hear much of anything else.

You will hear it again tonight—and tomorrow night. Listen to it for a few moments sympathetically, instead of with irritation. Listen hard, as you have listened for ball game scores when the radio has "faded" just at the critical moment. Strain your ears, and you will understand that what you thought was just a jagged rasping is a distressed voice crying "I am op-por-tu-ni-ty—opportunity—op-por-tu-ni-ty—Big Opportunity!"

A message that tells you of inexhaustible stores of energy in the atmosphere, striving to get to earth. Energy eager to do useful work, asking only that some one—any one—will provide harness and chariot; or, in more fitting metaphor, power wheel and crank shaft. Any sort of mechanism to link it with the ground, so that the divided powers of sky and earth (separated by insulating air) may work together.

ALL the centuries the two colossal powers have been thus severed. Spasmodically, fogs and rain help them to join hands. Now and again they break through the barrier and rush together in the frantic spasm of joyful greeting we call a flash of lightning. But never until radio came was there the chance to make the situation known to the public at large by persistent, day-by-day advertising.

Suppose you should find a way to let static charge batteries in quiet contentment, instead of clamoring its complaints over the wire. Every radio user in the land—every one of the twenty million to whom radio will be a necessity in the near future—would gladly pay you a few dollars for teaching them a trick like that. And that is only the beginning. Your method of bringing the electric stores of air and earth together may go far toward answering the insistent cry of the industrial world for Power, More Power!

Are there potential billions in such an opportunity? Or is it trillions?

"But," you say, "scores of learned electricians have tried to solve the static problem, and given it up. How can I succeed where such men have failed?"

Perhaps you can't. Yet there are some historic precedents to show that perhaps, also, you can.

WE HAVE airplanes because, after the wisest of American physicists, Simon Newcombe, had proved mathematically that flying was impossible, the young Wright brothers flew.

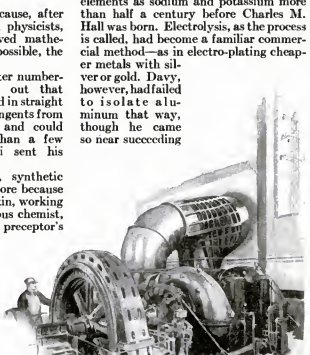
We have radio because, after numberless physicists had pointed out that electromagnetic waves traveled in straight lines and so must fly off on tangents from the earth's curved surface and could never carry signals more than a few miles—then young Marconi sent his signals across the Atlantic.

We have synthetic dyes, synthetic drugs and high explosives galore because an English youth named Perkin, working in the laboratory of the famous chemist, A. W. Hoffman, rejected his preceptor's admonition to throw away a mauve colored mixture he had accidentally made and used it instead as the basis of a billion dollar industry—which was well under way when the lad was twenty-one.

We have ideal utensils of aluminum, and millions of miles of electric wires, and automobile and airplane bodies, because an American youth named Charles M. Hall, at Oberlin college, and a French youth named Heroult independently challenged the belief of the scientific world that aluminum could be isolated only by elaborate and costly chemical or smelting processes—and proved with homemade apparatus that rapid and effective separation by electrolysis could be effected with a low-power current at a fraction of the cost of the other methods.

Shortly before that, aluminum had sold for ten dollars an ounce. It is now worth sixteen or eighteen cents a pound, and the annual output is upward of a quarter of a million *tons*. A billion-dollar industry sprung from a laboratory crucible in the hands of a college boy!

AND not through the discovery of any strange new principle. Merely by a new use of familiar principles. When you pass an electric current through a solution of a chemical compound of a metal, the metal is drawn to the negative pole of the battery. Sir Humphrey Davy gained fame by thus isolating such elements as sodium and potassium more than half a century before Charles M. Hall was born. Electrolysis, as the process is called, had become a familiar commercial method—as in electro-plating cheaper metals with silver or gold. Davy, however, had failed to isolate aluminum that way, though he came so near succeeding



And to those who work with electricity, opportunity cries out constantly for aid in becoming more useful to the world

that he named the metal, even without quite proving that it was an element.

The famous German, Wöhler, found out how to isolate small globules of aluminum chemically in 1845. The Frenchman, Deville, spent ten years trying to perfect a commercial method.

But no solvent could be found for aluminum minerals that would make electrolytic isolation of the metal feasible on a commercial scale. Hall reasoned that there must be some such solvent—and that perhaps he could find it. So he tested all aluminum compounds he could lay hands on.

One was a curious mineral from Greenland—a compound of aluminum with sodium and fluorine, called cryolite, or frost-stone, because it looks like ice and melts in the flame of a candle. Hall found that melted cryolite readily dissolves powdered bauxite, a mineral composed of aluminum and oxygen, with water of crystallization. He sent an electric current through this solution—and got a few globules of white metal at the negative pole. It was aluminum.

AND now for the present application of this story. Forty years have passed. Yet Hall's method remains in its essentials unchanged. Only certain native minerals, notably bauxite, can be utilized. The best supplies are limited to a comparatively few local deposits—in this country chiefly in Alabama, Arkansas, Georgia, and Tennessee. A vast deposit in British Guiana has recently come under American control. Obviously, the cost of transportation must be added to the selling price of the ultimate metal.

Meantime other native compounds of aluminum are everywhere. This is the third most abundant element in the world. It is a constituent of practically all rocks except very pure limestone and sandstone. It forms eight or ten per cent of nearly all soils, and is a dominant constituent of common clay.

But clay and the various feldspars and other aluminum-containing rocks are unavailable because they contain an admixture of the element silicon, which interferes essentially with the process of electrolysis.

But might not the silicon be removed, or rendered innocuous by some chemical or electrical manipulation?

That is the question. A handful of clay and the high-frequency current used by some radio amateur may perhaps found a new aluminum industry that will banish the bauxite method as Hall and Heroult established it.

Consider the place that aluminum already holds in the industrial world, the yet more important place it must hold as native supplies of copper, zinc, and tin are exhausted. Do you see the billion-dollar opportunity?

As a hint the import of which will be more evident before we are through, note that the now obnoxious silicon is next above aluminum in the atomic scale. Remove one proton from the silicon nucleus, and you have aluminum. We shall see that this has been done—by Sir Ernest Rutherford—in the laboratory.

But perhaps you do not care to dabble in clay. Then what about a little dip in water? A project worth considering.

Water, as everyone knows, consists of hydrogen and oxygen, in chemical combination. Split up the water molecule, and we have hydrogen gas and oxygen gas. Bring the two gases together, ignite them, and we have the oxy-hydrogen flame, which carves iron like so much cheese—or, under different pressure conditions, serves as an ideal fuel.

There need be no further bother about

The World Cries to You For—

A WAY to harness the immeasurable energy manifested by static in the radio and make it supply useful power.

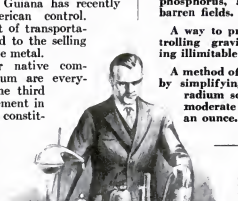
An inexpensive way to refine aluminum from the limitless rock and clay in which it exists.

A method to convert water into fuel gas at moderate expense, as can now be done at prohibitive cost.

Practicable ways to extract potassium from rocks and manufacture phosphorus, and thereby fertilize barren fields.

A way to produce power by controlling gravitation, thus providing illimitable power.

A method of making gas from air by simplifying the production of radium so that its cost will be moderate instead of $3,000,000 an ounce.



Besides fame and the joy of service, here is the reward

coal or fuel oil if the hydrogen of water could be cheaply released.

Cheaply released. That is the whole story. The way to split it up with an electric current was discovered by the Englishmen Nicholes and Carlyle 125 years ago. The experiment of "burning water" with sodium metal or potassium metal is performed by students in every chemical laboratory. Either process might be feasible on a commercial scale were it not for the cost.

THAT was what stood in the way of getting nitrogen from the air to replenish the exhausted agricultural fields at the beginning of the present century. In an electric arc, as had long been known, nitrogen will unite with oxygen—but at a prohibitive cost. Presently, however, it was discovered—by Birkeland Eyde, in Norway—that a magnetic field would spread out the arc, and so facilitate the union of nitrogen and oxygen as to make the project commercially feasible.

The most curious part of that story is that, almost before this manner of fixing nitrogen had ceased to be a novelty, other and better ways of accomplishing a corresponding result were devised, with the aid of heat and catalysts; notably the Haber-Ostwald process, making ammonia and then nitric acid; and the cyanimide process of two other Germans, Caro and Frank, which consists of passing nitrogen from liquid air over white-hot calcium carbide.

ONE of these days, some keen young fellow, who will probably get his introduction to practical electricity through manipulation of a radio apparatus, may find out how similarly to magnify the effect of an electric current in splitting water into hydrogen and oxygen—perhaps with the aid of some simple catalyst that lies near at hand, its potency unsuspected.

But perhaps you are an ambitious young chap, and would like to tackle a really formidable problem.

Well, there are several sources of cosmic energy which, when we stop to think of them, fairly stagger the imagination; yet which are perhaps no more inaccessible today than electricity, as a working force, seemed a few generations ago.

What, for example, if we could control gravitation, in the sense that we now control electricity?

Imaginative men have long pondered the conception of "negative gravity." The idea is suggested by the observed linkage of positive and negative polarities in the electric and magnetic forces. Gravitation appears to be a mutual pull between every pair of particles of matter in the universe. What if the pull, under certain conditions, could be reversed—turned into a push, that would make the particles mutually repel one another, like electrified bodies of the same polarity?

A demagnetized piece of iron no longer attracts other pieces of iron. If any substance could be degravitated—made oblivious to gravity as glass, for example, seems oblivious to magnetism—such a substance would tend instantly to fly off into space—at cannon-ball speed—propelled by the momentum acquired from the whirling globe.

Such a substance would obviously become a projectile or working mechanism of appalling power.

BUT if you think the job of harnessing the world forces too strenuous or too dubious, there remain plenty of other worlds to conquer.

Consider, for instance, how great is the world's need of larger and cheaper supplies of the two chemical elements which, with nitrogen, form the great triad of plant foods that become exhausted in cultivated soils, so that the richest acres are sterile unless the lost elements are replaced. I mean, of course, potassium and phosphorus.

There is, to be sure, abundant supply of potassium scattered through the rocks of the earth's crust. A method to extract the potassium content from the feldspar rocks that cumber the barren hills of tens of thousands of New England acres, for example, would forecast a new era of prosperity.

A phosphorus (*Continued on page 154*)

Dodging Death On the Wires

Linemen Struggle in Icy Storms Without Food or Rest to Repair Phone Lines That Sputter Tragedy

By Robert E. Martin

Above: A cable splicer taking his chances with forces of electricity and gravity 50 feet in the air. Below: A perilous balancing and soldering act

THOSE fellows are playing with red-hot death!"

My friend Bill, who has spent half his life at that very kind of "play," in and about New York City, jerked his head upward toward a cluster of linemen on a telephone pole, silhouetted against the dusk.

"Once you've flirted with fifty-seven varieties of danger on top of a thirty-five-foot stick," Bill went on, "life on the ground seems mighty tame—especially on a night like this, with a storm tearing the wires into tangled havoc."

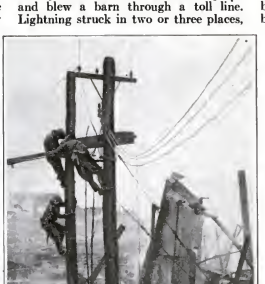
"Risky?" I asked.

"I'll say it's risky. There's probably 2200 volts—maybe 4500, maybe 7000—sizzling along the light wires just above the heads of those 'pole roosters.' Five hundred and fifty's enough to knock a dozen men cold. Not a healthy neighbor, that hot stuff, when everything's soaking wet to help it move all sorts of places where it isn't wanted."

BILL was right. It's risky and it's hard. A telephone lineman doesn't exactly sleep in his spurs, but he takes them home with him nights. He's always ready for instant duty—duty that may mean twenty-four hours' straight struggle with miles of tangled light wires, trolley wires, telephone wires, all spitting danger—struggle in cold that bites like a knife with lines coated three inches thick with ice—legs stiff from climbing slippery poles, heads giddy from lack of food.

"But in winter it's harder than it is dangerous," said Bill, "though its always dangerous enough. You've got to keep your head. A careless move, a wrong touch, and good night! In a hard winter storm the current is pretty sure to be cut before the linemen reach the scene; in summer the light wires on the same poles may be undisturbed, full of deadly 'juice,' and the phone men have to work up there in the dark with death sputtering all around.

"A FEW years ago a June storm killed four thousand phones in this county, tore down three hundred poles, and blew a barn through a toll line. Lightning struck in two or three places,



Linemen on the job among death-sputtering wires had service well on the way to full restoration before the $1,500,000 fire that wrecked two Jersey City piers had finished its nine-hour ravages

and two hundred cables were burned. It took three hundred men five days before things began to get back to normal.

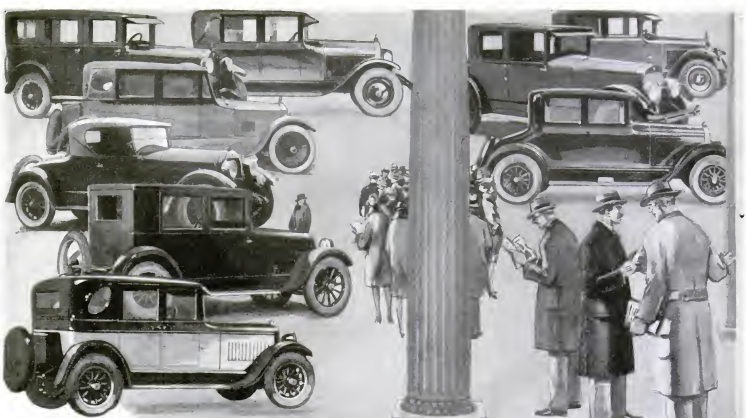
"I saw two fellows keeled over that time. They were standing in a puddle, helping hoist a pole, wet and green, into a hole. The top of it hit a high-tension light wire and ten thousand volts shot down it and through those fellows into the ground.

"A heavily charged pole I tried to climb knocked me down three times before I made a running jump and sank both spurs in it three feet above ground. You see, I was safe as long as I wasn't grounded."

SAFETY first campaigns have materially reduced casualties among linemen, and power companies have helped by improving insulation, but some insurance companies still refuse linemen, and some others are likely to put them among special risks. Oddly, the accident records show the safest place for such workers is up among the wires, largely because they are more cautious there. Most mishaps are from handling material and tools. A tool dropped from a pole has laid out many a man. That's the reason the men are instructed to take only pliers, wrench and knife up a pole and to fish for the rest with a handline. More linemen are laid up by poison ivy than by shocks; although the latter, constituting less than ten percent of the accidents, are generally the most serious ones.

"Once, on the aqueduct transmission lines," said Bill, "we'd just finished with the right-hand side of the booster transformer, and the white flag was given, the signal to cut the current in. The current was cut in—on the wrong side They say I crumpled and hung from my

(Continued on page 129)



"What Car Shall I Buy?"

Gus Finds in So Many Autos of Merit the Problem That Confronts Us All and Puts Client's Query Up to You

By MARTIN BUNN

"HOW about giving the Auto Show the once over tonight?" suggested Gus Wilson to his partner as they were closing up the Model Garage for the night.

"I'm game," Joe Clark replied. "Stop around for me any time after eight."

"Can't you make it earlier? I'll have Bill Crowley in tow. He wants me to help him pick out a car."

"What!" exclaimed Joe. "Bill Crowley going to buy a car! Why, he's always saying he hates automobiles!"

"Yeah," grunted Gus, "that was when he was broke. But he's made money recently, so he can afford a car now."

Joe grinned. "Well, I sure don't envy you the job. No matter what car you recommend, if he has any trouble with it he'll blame you."

"No, he won't," contradicted Gus as he shuffled his muscular frame into his overcoat. "I've got a scheme to beat that. You watch how I work it."

Joe was just finishing his supper when he heard Gus's horn. Bill Crowley was already in the car.

"So the bug has stung another victim," grinned Joe.

"Yes," Crowley admitted sheepishly, "it's got me at last. I guess the only cure is to buy one; but what gets me is which to buy, they all look so good."

"Now," said Gus, as they passed into the vast hall filled with shiny, new models, "before we start going the rounds let's figure out about what type of car you want, and how much you can pay, and also let's see if you have any particular requirements that might affect your choice. How big is your family, Bill?"

"Four, the wife and I and the two kids. One of 'em is eight and the other six."

"Is your wife going to drive?"

"Yes," Crowley replied.

"THEN I can see one mistake you've made right at the start," asserted Gus. "You should have brought Mrs. Crowley along. She'll have a lot to say about the type of body and the color scheme."

"That's what I thought when I first brought up the question, but she says she doesn't know one car from another and doesn't care what kind I get so long as I get a good one and get it right away."

"All right," said Gus, "now tell me how much you want to spend, and we'll look over all the cars in that class."

Crowley hesitated. "I haven't decided that either," he confessed. "I can spend up to a couple of thousand dollars, but naturally I don't want to spend any more than I have to."

"HUMPH!" grunted Gus. "How am I going to suggest a good car to buy when you haven't any idea what kind you want or how much you think a car will be worth to you? Well, let's get started and see if we can't pick up some good ideas."

They moved slowly from exhibit to exhibit and examined each glistening machine. Now and then Gus halted before one and briefly pointed out various mechanical and body design features.

"Of course," said Gus as they stopped to admire a particularly good-looking coach, "it isn't so hard to point out the types of cars you shouldn't buy. For instance, you certainly don't want a roadster, even one with a rumble seat in the back for the kids, because you will want to use the car in rainy weather and in the winter, and the passengers in the back seat have no protection at all.

"You might want an open touring car instead of a closed model, but that would

Rather bewildering is an automobile show with seemingly innumerable cars, each with its own appeal. Choosing a car that fits your own particular needs is a real problem

depend on how you use the car. If you want it mainly for trips about the country when the weather is good—real pleasure driving—then an open car is fine; but if you want to combine pleasure driving with comfortable transportation in any kind of weather, you'll want a closed car. Most of the open cars sold today go to old birds like me or to families owning more than one car. Of course lots of cheap open cars are sold, but there price is the main factor."

"How many cylinders ought a motor to have?" asked Crowley as he craned his neck over the shoulders of a crowd gathered round an eight-cylinder chassis.

"THAT depends on what features you value most," Gus replied. "From the standpoint of reliability and general utility it makes no difference whether you get a four, six or eight. Most of the possible sources of trouble lie outside the cylinders. If the ignition system goes bad, for instance, it will stall an eight just as quick as it will a four-cylinder car, and the same applies to many other troubles."

"But the sixes and eights must have some advantages or they wouldn't sell any," objected Crowley.

"Certainly they have," Gus agreed. "The more cylinders, the smoother the engine runs and the more flexible and quiet it is. Also, it is easier to build a motor with plenty of power by using a lot of small cylinders than to use four big cylinders with correspondingly heavy pistons that would cause excessive vibration."

"What's the advantage of long wheelbase?" asked Crowley, seeing a sign listing the lengths of wheelbase obtainable in a certain model.

"The longer the car, the easier it rides, other conditions being equal," Gus explained. "On the other hand, a long car is harder to handle in traffic, and it takes more space to park or turn around in."

"WELL," said Crowley, as the three men stood gazing out over the sea of cars and people after they had examined every exhibit, "now that we've seen them all, what shall I buy?"

Gus revolved the question in his mind. "That's a tough one to answer," he finally replied. "Your family is about the average size. You want to use the car in an average way. You are of average size; the average driving seat will be comfortable.

"You don't seem to have formed any opinions or acquired any prejudices. I'll be hanged if I know what to advise—tell you what we'll do—let's put it up to the readers of POPULAR SCIENCE MONTHLY!"

A Chance to Earn Ten Dollars

GUS, whose automobile wisdom has proved so valuable and interesting to readers of POPULAR SCIENCE MONTHLY, has put up to you the problem of selecting a car for his friend, Bill Crowley. What make and model would you buy if you were in his place and why? Name the car. Do not say merely a "five-passenger sedan," if that is the type of car you think Crowley should have. Give the actual name—Cadillac, Buick, Ford, or whatever it is.

Mr. Bunn, Gus's literary sponsor, plans to publish in an early issue of this magazine the best letters of advice he gets from our readers. And he will pay $10 for every letter published.

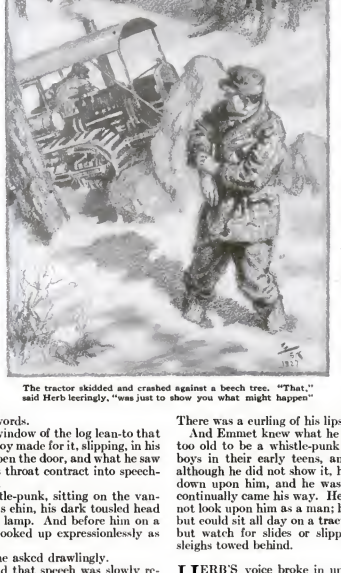
Advice from everybody, everywhere, is welcome, whether based on personal experience, the experience of friends, or observation of the results other people get with their cars. No restrictions are laid down; it is not necessary to own or drive an automobile.

Sit down and tell us what make of car and type of body Bill should buy and give five reasons for your opinion. Keep your letter within 200 words. Address it to Martin Bunn, care of POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City. And mail it so it will reach him not later than February 1, 1928.

Whistle-Punk

The story of a boy who wanted to be a mechanic, and his winning fight with the crookedest man in the lumber camp

By
PAUL COONRADT
Illustrated by
HARRY FISK



The tractor skidded and crashed against a beech tree. "That," said Herb leeringly, "was just to show you what might happen"

THE Old Boy was at his wits' end. There went the bell on the tractor again, and the whistle-punk was still missing. He went to the door of the cook-shack and bellowed:

"Emmet!"

There was no answer. He waited a few seconds, his troubled eyes on the graying east. Then,

"Emmet!" the second time.

Well, by the jumpin' Judas! This was the limit. Herb had been sitting in the tractor cab a good ten minutes already, and the loaders were at the skidway. He didn't like to have Herb kept waiting, especially this morning. The Old Boy had had words with the driver only a few minutes before—stinging, caustic words.

A light glimmered feebly in the window of the log lean-to that they called the "office." The Old Boy made for it, slipping, in his frenzy, on the icy path. He flung open the door, and what he saw made his mouth drop open and his throat contract into speechlessness. He just stood and stared.

For there was Emmet, the whistle-punk, sitting on the van-box, one long leg hunched up to his chin, his dark tousled head bent into the light of the kerosene lamp. And before him on a rough desk was a book. Emmet looked up expressionlessly as the Old Boy slammed the door.

"What yuh say, Mr. Codgy?" he asked drawlingly.

The Old Boy stuttered and found that speech was slowly returning.

"I ain't said!" he shouted hoarsely. "But I'm goin' to." The old fellow looked around wildly, first at the boy, then at the book. "What you doin' in here? Don't you know Herb's been waitin' fer ye ten minutes already? Didn't ye hear the whistle?"

Emmet looked at him dazedly. "I didn't hear nothin'. I got interested—"

"A good time o' day to git interested in anythin' 'cept work! It's most six o'clock, and ye been drawin' down pay fer one solid hour already when ye oughta been down greasin' the tractor. Put down that book and git out o' here!"

EMMET looked sheepishly at the Old Boy, and tried to cram the book into his pocket. It would not go, so he slipped it into the front of his shirt.

"Leave that book here, I told ye! First thing ye know ye'll be readin' that trash while ye're punkin', an' somethin'll happen."

"'Tain't trash," the boy said slowly.

"What is it then, if it ain't?" the Old Boy said sharply.

"It's litterchure."

"Litterchure in a pig's eye! I'll litterchure you." He looked steadily at Emmet for a second. "I'm tellin' ye now—once more I find ye like this in the mornin' and ye're fired. Hear?"

"Yeah," the boy dragged, his voice showing not the least strain of emotion.

And with that he walked slowly out of the office and down the hill to the tractor shed, the Old Boy gabbling threats after him.

The tractor was running, but muffled low, its exhaust sending out gulping puffs of steam in the cold morning air. Herb, the driver, was slouched in the driver's cab, sucking on a dead pipe.

Emmet climbed in beside him without a word.

"Thought you'd come to work after all, did you?" Herb leered.

"Why can't yuh let a fellcr know when yer ready?" the boy asked.

"Rung the bell three times. 'Sides, it ain't my job to go around collectin' whistle-punks." There was a curling of his lips on the last word.

And Emmet knew what he meant. He knew that he was far too old to be a whistle-punk; that whistle-punks were usually boys in their early teens, and he was twenty. Furthermore, although he did not show it, he knew how all the loggers looked down upon him, and he was not unmindful of the jibes that continually came his way. He realized that the lumberjacks did not look upon him as a man; he did not have to use his muscles, but could sit all day on a tractor load of logs with nothing to do but watch for slides or slipping chains on the long string of sleighs towed behind.

HERB'S voice broke in upon his thoughts like the crashing of gears.

"What you think I let you ride inside fer? An ornyment? Be you goin' to give the signal to start, er sit there an' moon all day?"

"Oh," Emmet said, and reached up and pulled the bell cord.

Herb always let the boy ride in the cab to the skidway, but he always insisted upon keeping up the disciplinary form of start and stop signals. As the bell rang, the tractor driver threw the gears into low and cautiously guided the machine down the slope to the level going.

"Old Codgy say anythin' about me?" he asked after awhile.

Emmet shook his head.

"Said this mornin' he was goin' to fire me," Herb continued with a sneer. "'Go on,' I says. 'Go ahead and fire me!'" The man's laugh had a snarling quality. "He don't dare fire me."

"Giss he could fire yuh if he wanted to. Seems like he's boss around here," the boy answered dryly.

Herb eyed him sharply. "That's right! Go on stickin' up fer the old fool and see how you come out!" Then, after a minute, "Don't know what you got to stick up fer him fer—a whistle-punk," he threw at the boy.

"He's treated me all right." The boy put his hand inside his shirt and drew out the book he had concealed there. "Give me a fountain pen fer Christmas," he added.

"Yes, and he didn't do it fer nothin'. Either yer awful dumb

Emmet's long right arm shot out again and made a contact with something hard, and the big driver's body crumpled to the floor. He heard the voice of the Old Boy above the rest: "The kid ain't no whistle-punk. He's a fighter! Two of the cleanest knockouts I ever see!"

er you know more'n is good fer you. A whistle-punk a man of your age! He kin git a kid to work fer the wages you git."

"Ain't heard me say nothin' about wages, hev yuh?"

"No, and that's jest what I'm gittin' at. Looks like he's givin' you somethin' on the side so's you'll tattle when a man tallies up a few hundred feet on the side fer Juniper money."

"I ain't said nothin'. If I told him what I knew, I giss I'd have a right to ask fer more pay."

"You shut yer blabbin' mouth about me, see?"

"I ain't told nothin', I said."

THE boy opened the book he had drawn from his shirt, and the movement caught Herb's eye.

"What the——Say, you put that book up, now. Put it up!"

Emmet looked up at him calmly. "Don't see no harm readin' till I git to the skidway."

"Le's see it!" the driver commanded.

"I don't never let nobody monkey with my litterchure."

"Litterchure?" the man scoffed with a curled smile. "What you mean, litterchure?"

"Why—why—litterchure—this here is litterchure," he stammered with an awkward smile.

"What you talkin' about? That's a *book*. Le's see it."

The man at the wheel made a dive for the book, steering with one hand, but Emmet was too quick for him, and had the book back inside his shirt in a twinkling.

"Keep it there, then, you poor punk." A scowl came between Herb's eyes, and his red, wind-beaten face became almost purple. After a pause he added, "I'm tellin' you, now, try buckin' me an'—an'——"

Emmet was looking out the cab window, watching the snow-laden spruces that were shooting by. Without turning his head, he said,

"An' whut?"

"An' I'll fix you like I fixed that punk last fall."

Emmet did not answer. They came in sight of the skidway, and Herb said:

"Sometimes I think you're jest dumb—so dumb you don't know when you're apt to git a pile o' logs rolled on you."

Besides the desk and the van-box in the office, there was an iron bed, heaped with tossed-up blankets. On nights when the shanty boy kept a fire going Herb slept there; if it was cold, he would go to the loft over the cook-shack, and Emmet would take the office bed.

That night after supper the Old Boy, making his usual evening pilgrimage around the buildings, found the office unoccupied. He went in and sat down on the van-box.

He relaxed, and his eyes, fixed on the smoky-brown kerosene lamplight, were vacant with thought. His heavy, red jowls sagged. After awhile he drew a tally sheet from his side pocket and studied it until his eyes became blank again.

He wished he could get something on Herb. The tally sheet looked right enough, but it stood to reason something had happened to the logs that he did not know about. It had been a first-rate week for sleighing, and logs had left the skidways in a steady stream. Maybe he was getting old and his eyes were deceiving him. But still, there were fifty thousand feet on the Windfall skidway alone, and the tally showed that only thirty thousand had been drawn to the mill. He'd stake his life that there were fifty thousand there on Monday. His mouth sagged more and more as he pondered.

The door opened and closed softly. The Old Boy looked up.

"Why hello, Emmet," he said.

"Hullo." Emmet came over and sat down upon the bed. "Giss Herb's goin' to sleep in the loft tonight. Turnin' colder out."

FROM his shirt he drew the book and opened it to a turned-down corner.

"Jest what is that there book, Emmet?" the Old Boy asked.

"Oh, jest readin'." The boy tried to appear unconcerned, but the Old Boy noticed that he concealed the cover by holding it against his shirt.

"Say, Emmet, ye don't wanta get huffy about what I said this mornin'. I didn't mean nothin'."

"I didn't notice yuh said nothin'." Emmet avoided the older man's eyes.

And they sat quiet for a long time. The wind sobbed through

the spruces outside the building and whined in the stovepipe.

"Well, this kind o' weather is better'n a thaw," the Old Boy observed indifferently after a time. Emmet had opened the book and his eyes were fixed on the printed page. He looked up inquiringly at the man's words. "Say, boy, ye want to spoil yer eyes?" the Old Boy added.

"I wasn't readin'. Jest thinkin'. Makes a feller think sometimes when he's lookin' at somethin' he don't understand—like a lot o' words."

HE ROSE quickly, embarrassed at his own self-expression, and threw a two-foot chunk into the stove.

"Say, Emmet—" the Old Boy's eyes had an expression of helplessness; there was something in them that pleaded with the boy for his confidence. He waited a minute, then, "Say, I think something's wrong about this tally sheet."

The boy came back and sat down.

"Seems like they'd drawed more logs than this—don't suppose Herb's in thick with the tally boss, do ye?"

"Dunno." The boy had opened his book again and was trying hard to read.

"Didn't never see him monkeyin' 'round with the tally down to the skidway, did ye?"

"I never noticed. I set in the cab and read most generally."

"Herb say anythin' this mornin'?"

"Nothin' more'n usual."

"I told him I'd fire him. Wish I could." He looked at the boy closely. "Seems like ye oughta learn how to drive that tractor some day."

"Mebbe I could."

"Ye gotta show more spunk. A feller don't git ahead in this world mopin' over books. I'm tellin' ye fer yer own good."

"Some says as how fellers does git ahead from readin'."

"Won't learn ye how to drive a tractor or keep tally."

"Can't never tell," the boy said dreamily.

They sat in sileuce. The kerosene light burned low and began to flicker. The light from the stove grating made long red fingers on the floor.

"I found out why I can't git no men," the Old Boy resumed. "I hear down in the valley Herb's tellin' around that they pay a dollar a day more over to the Black River camp. Everybody down to Homesville thinks I'm payin' less than anybody else. They're tellin' the lumberjacks that come through lookin' fer work, and it's sendin' 'em all over to McGuire's camp. Can't blame the valley folks fer tellin' what they hear."

"No, giss yuh can't."

"THEN Herb comes back here," the Old Boy went on, "and gits the men all stirred up with that talk of his and they all start packin' up to leave. That's why I told Herb I was goin' to fire him this mornin'." He paused. "But I ain't. I can't. The job 'd be all shot to pieces with nobody on the tractor."

"Yis, giss it would."

"You guess it would!" The Old Boy's voice was shrill in exasperation. "Don't ye *know* it would? Don't ye know nothin' 'cept to agree with everythin'? What ye suppose I pay ye fer? Settin' on a load of logs and readin' all day? Well, I ain't. I'm payin' ye to use yer head once in awhile." The Old Boy rose and came over to the bed where Emmet was half-reclining. "Ye don't git much money, but ye git a good wage fer a whistle-punk, and yer supposed to earn it. Yer supposed to know why the tractor gits broke up every few days and why they's so much tippin' over and slides. If ye'd show some spunk and keep yer eyes open, ye wouldn't have to be a punk all the rest of yer life." The old man puffed in his vehemence. He trod heavily over to the stove and back, his eyes never leaving the boy.

Emmet seemed not to notice. His lips moved finally, but he spoke as if it were an effort.

"Pa used to say—he used to say, 'Give the Devil enough rope, and he'll hang hisself.'"

"What's that mean? What's that got to do with it?"

"Oh, nothin'."

The Old Boy snorted in disgust and started angrily toward the door. "Don't know what I'm wastin' my breath on a whistle-punk for. Guess mebbe you're as bad as the rest of 'em, or else yer so durn lazy ye jest don't care."

"Giss mebbe that's it, Mr. Codgy. That—and kinda interested in litterchure."

The Old Boy stamped out, slamming the door on Emmet's words. The boy rolled over, pulled a scraggly blanket up to his ears, and was instantly asleep.

* * * *

The men filed into the cook-shack for breakfast. Their gait was slow, their eyes averted. None of them spoke to the Old Boy, who was already eating potatoes with bacon grease at the head of the long, scrubbed table. Old Codgy, too, kept his eyes on his plate with only occasional side-glances down the row of sullen faces. He could tell, the Old Boy could, when there was an ill wind blowing. He could tell by their downcast eyes, their chewed-up mumbling, incoherent except between themselves, that Herb had been talking to them again. He had suspected it the night before when he heard him come up the loft stairs.

There was the whistle-punk on the van-box, one long leg hunched up to his chin, struggling with a book

HERB came in after the rest and sat near the foot of the table. Emmet was already there, eating rapidly. The men bolted their pancakes and hurried off to the bunk houses.

Herb was one of the last to leave the cook-shack. As he passed Emmet, he halted a second and said out of the corner of his mouth:

"I got somethin' to say to you. I ain't goin' to ring no bell fer you neither."

Emmet lingered over an extra cup of coffee after the rest had gone. He, too, felt the note of unrest. He looked up as the Old Boy rose and started toward him.

"Say, Emmet—" the Old Boy looked down at the whistle-punk and the boy saw that his eyes were dark-rimmed and hollow. "Say, I'm jest tellin' ye, they's somethin' up. Don't go and git into trouble because—fer—fer him. Last fall he let them logs roll on the other punk, and mebbe he's layin' fer ye. Ye been a good boy, even if ye ain't no lumberjack. Mebbe that's why I've kinda took a notion to ye." He leaned over and blew out one of the kerosene lights on the table. The sky came through the window opposite in cold, dirty gray. "Mebbe it's cause ye read them books and ain't jest like the rest that I kinda got faith in ye."

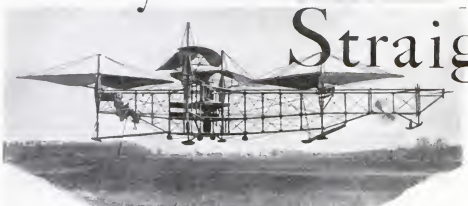
The boy grinned foolishly. "Aw, shucks," he said, "I ain't havin' nothin' to do with him."

"See that ye don't. Hear?"

Emmet nodded. "Giss I better be gittin' on the job."

The Old Boy opened his mouth as if to speak, then shut it. Emmet rose and left the cook-shack. *(Continued on page 144)*

Why Don't We Fly Straight Up?



The Oehmichen helicopter, with four huge lifting propellers fashioned after bird wings, and others to balance the machine while in the air and for forward propulsion

We Can and Will, Says an Air Authority, and Helicopters Will Vie with Planes When the Problem of Endurance Is Solved

By ELLSWORTH BENNETT

LATE reports from England reveal that the British Air Ministry has purchased the plans of an Italian engineer, Isacco, for a plane capable of rising straight up into the air—a type of flying machine long sought by inventors.

In America, a recent report aroused wide interest, despite the company's refusal to confirm it, that the Curtiss aircraft organization was building a vertical-rising craft similar to the Italian's.

Small air-cooled motors would whirl a twin-bladed horizontal wing mounted upon an airplane frame and lift the odd Isacco craft against the force of gravity.

Are we to have, at last, a helicopter—a craft that can rise vertically, hover stock-still, and descend at will into a space no larger than itself on a roof top or in a back yard? Already there exist curious, wingless craft of metal frames, supported by huge propellers alone. How far have their inventors progressed? Where does the helicopter stand in its development?

"Exactly where the airplane stood after the first few flights of the Wright brothers." The speaker was Dr. George de Bothezat, aeronautical expert, designer of a helicopter built and flown for the U. S. Government, and discoverer of fundamental principles of air motion now widely applied in the manufacture of all types of aircraft.

"HELICOPTERS have flown," Dr. de Bothezat told me. "They have carried two and three passengers and a pilot into the air. They have ascended, generally a few feet, under their own power. They have demonstrated beyond question that the mastery of vertical flight is within our very grasp." And in a few vivid words he showed me why we are nearly, but not quite, ready to fly straight up. Tomorrow, you and I may fly in them. "We cannot avoid it," Dr. de Bothezat assured me.

Yet—today, frankly, helicopters appear at a standstill, this expert declares. "To the best of my knowledge," he said, "no serious experiments are in progress either here or abroad." For the helicopter still has to make its reputation as a successful competitor of the airplane, and those who would attempt to solve its unique problems must be prepared for heavy expense and possible disappointment. Just what these problems are, Dr. de Bothezat pointed out for me.

HOW can you keep a helicopter from tipping over? That is the most perplexing question that would face you, should you attempt to design one. To create a craft that can rise in apparent defiance of gravity is not so difficult. It has been done repeatedly. Propellers revolving in opposite directions keep it from whirling like a top. But will it stay right side up and level?

A free flying craft cannot be kept upright by hanging most of its weight at the bottom—it no longer obeys the laws of fixed bodies! To keep it from tipping over in mid-air and crashing to earth—

Upper picture: The von Karman "captive helicopter" at a height of 150 feet with two passengers in barrel-shaped cabin. It had shock absorbers on the bottom, and three ropes operated by a ground crew kept it balanced. In a later experiment this machine tipped and fell, injuring pilot and passenger

Lower picture: An inauspicious attempt at flying straight up. A French inventor built a helicopter and by way of experiment tried to rise with his machine roped to the ground so that some control beside the pilot's could be kept over it. But the tether unbalanced the helicopter, which crashed

and from rocking like a ship in a stormy sea—is the stumbling block of many an inventor.

Adequate safeguard if the motor fails is equally important. Since an airplane can, if high enough, glide to a safe landing when the motor stalls, some inventors have attempted to combine airplane and helicopter in a single machine. The designer of the true helicopter seeks to make his propellers themselves large enough to check a forced descent.

Motor must be powerful enough and propellers efficient enough to lift the craft to any altitude.

IMPROVED motors and lighter fuel are not a necessity, Dr. de Bothezat points out; helicopters that can get off the ground at all can rise thousands of feet if nothing goes wrong. The real reason they have not done so is that no pilot would take the chance! When you drive an automobile for the first time, you do not run it with the speed throttle wide open; you must first learn to control it.

There is, to be sure, a slight uprush of air, the reflected blast of the helicopter's propellers, that makes easier the first few feet of ascent; but this amounts to only about five percent of the total lift and vanishes at a distance from the earth equal to half the diameter of the propeller.

Directed horizontal, as well as vertical, flight must be within the power of the successful helicopter and its controls must be as easy to manipulate as an airplane's. In helicopters that have been built, forward motion—if provided for at all—is accomplished either by small auxiliary propellers or by tipping the whole machine frontward. Extremely ingenious mechanism has been devised to accomplish this.

FORMIDABLE as the many complexities appear, there is ample incentive to solve them. We need a successful helicopter not entirely to replace the airplane, but to supplement it. Helicopters, Dr. de Bothezat foresees, will some day buzz with mail and passengers over congested city streets alighting on roofs; for, unlike airplanes, they will need no landing fields.

At sea, he says, voyagers on near-by ships will visit each other in helicopters. Their possibilities in war are unlimited.

Airplanes, Dr. de Bothezat says, have a definite speed limit—about 400 miles an hour. At such speeds, which we are just approaching today, an airplane's wings create a dangerous drag that is apt to cause nose dives. But the true helicopter, according to aerodynamic laws, has no speed limit! It is unique in that it uses its entire "wing" surface—its propellers—for propulsion. There is no dead wing area to act as a drag; with the sole, negligible exception of the helicopter's thin frame, all its surface is active, not passive. Hence its velocity depends alone on the power of the motor, Dr. de Bothezat concludes.

Thrilled by such possibilities, inventors have wrestled with gravity to conquer the secret of vertical flight, giving aviation one of its most fascinating chapters.

First hovering (hanging still in air) by de Bothezat helicopter, with pilot, in free flight. Trailing rope indicates height of 15 feet

A demonstration of stability and lifting power. De Bothezat helicopter keeps level in the air, despite three men hanging from corners, the fourth corner unoccupied

A later Berliner airplane-helicopter hybrid. Huge propellers lifting; standard one gives forward motion

One of the early experimental helicopters of Emile Berliner. This machine could not carry men, but it was able to lift its own weight into the air

The Argentine engineer, Pescara, working in France, got his third craft up a few feet while two men steadied it. With a fourth he tipped over and crashed. Undaunted, Pescara equipped a later model with poles attached to the wheel hubs; by flying a few feet above the ground, and bouncing off it with acrobatic skill on these "skids," he was able to jockey his craft to keep it right side up. His seventh machine annexed the French distance record for helicopters of 2414 feet and stayed in the air several minutes.

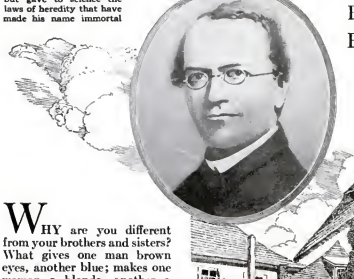
Propellers shaped like a bird's wing were a feature of another helicopter built by the Frenchman Oehmichen. He hitched his second machine, with no one in it, to a balloon, where it showed such lifting force that he was encouraged to build more. Later he flew man-carrying machines for short distances without the balloon's aid. Oehmichen was one of the few helicopter designers to make a serious attempt to balance his helicopter at any height in the air; he added four extra propellers to aid in balancing, and one for forward motion, controlled in flight by the pilot.

TO RUN an electric-motor helicopter by a cable from the ground was the unique proposal of Prof. von Karman, Austrian inventor. Experiments proved, however, that gasoline motors were more suitable; and he built among other types a three-cornered helicopter with a passenger cabin above the (Continued on page 125)

Is Your Son Like You?

A Monk's Laws of Heredity, Ignored For Years, Now Explain Differences Between Members of the Same Family

By L. G. POPE



Gregor Mendel, who lived and died a devout monk, but gave to science the laws of heredity that have made his name immortal

WHY are you different from your brothers and sisters? What gives one man brown eyes, another blue; makes one woman a blonde, another a brunette?

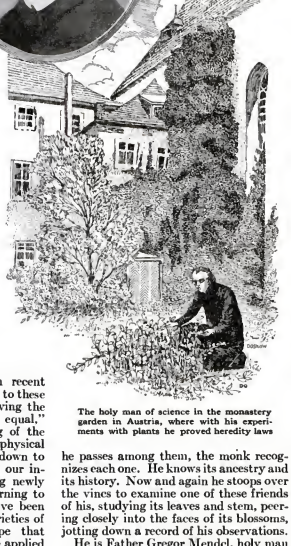
Some of us are naturally thin, others stout; some tall, some short. Some are subject to diseases that others resist. These folks are talented as artists, those as engineers, mechanics, mathematicians. Certain men find it easy to make a fortune, while certain of their fellows have a hard time getting along. Why is this?

And how does it happen that great geniuses sometimes spring from lowly hovels, and ne'er-do-wells from mansions of plenty? Why is it, in short, that every living creature comes into the world different from every other?

Biologists and naturalists, in recent years, have begun to find answers to these puzzling riddles of life. Disproving the idea that "all men are created equal," they have discovered something of the amazing processes by which our physical and mental equipment, handed down to us from past generations, shape our individual destinies. By applying newly found laws of heredity, and learning to control these processes, they have been able to breed new and better varieties of plants and animals, and hope that eventually the same laws may be applied to breed better human beings.

SINCE the beginning of the present century these remarkable discoveries about heredity have given the world an entirely new understanding of creation. Yet, they originated not in the great halls of a modern laboratory, but in the cloistered garden of a monastery.

Travel back, in imagination, sixty-odd years to the old monastery of Königenkloster, in Brünn, Austria. Into the garden, when morning prayers are said, hastens a black-robed Augustinian monk, a sturdy man with strong jaw and piercing eyes. Everywhere are pea vines in blossom—of many kinds and hues. Yet, as he passes among them, the monk recognizes each one. He knows its ancestry and its history. Now and again he stoops over the vines to examine one of these friends of his, studying its leaves and stem, peering closely into the faces of its blossoms, jotting down a record of his observations.



The holy man of science in the monastery garden in Austria, where with his experiments with plants he proved heredity laws

He is Father Gregor Mendel, holy man of science. The garden is his laboratory. Day after day, year after year, he observes the cycles of reproduction—the seeds giving forth green stalks; the plants unfolding blossoms; the blossoms producing seeds from which, the next year, will spring a new generation. He mates one plant with another. With infinite patience he traces the offspring, generation after generation. Until at last his labors are rewarded by a revelation of fundamental laws of heredity by which Nature brings forth life in myriad forms and characters.

It was in 1865 that Gregor Mendel, standing before the Natural History Society of Brünn, first announced his revolutionary discoveries. To his amazement, his work received no recognition and was soon forgotten. But he accepted disappointment philosophically. "Meine Zeit wird schon kommen," he told his friends with a smile—"My time will soon come."

And though he did not live to see it, his prophecy came true. Buried in obscurity for thirty-five years, and rediscovered at the beginning of the present century, Mendel's laws of heredity today are universally accepted. Experiments without number have demonstrated their soundness and vastly extended their application, giving us wonderful new kinds of grains, vegetables and flowers; splendidly improved cattle and horses.

MENDEL'S own life afforded an example of the surprising way in which Nature sometimes brings forth greatness in lowly places. Poverty stood between the Austrian peasant lad and the education he craved. His sister gave up her small marriage dowry to send him to school. Graduated at twenty-one, he entered the monastery, where he began to study plants, first as a "hobby." This work, as well as his success as a teacher of natural history in the technical school at Brünn, attracted the attention of his superiors, who enabled him to continue his studies at the University of Vienna. Two years later, his course completed, he returned to the monastery and undertook his revolutionary experiments.

Significantly enough, Charles Darwin was startling the scientific and theological worlds with his "Origin of Species", in which he laid the foundation for his theory of evolution. Although Darwin relied on the obvious variations in living plants and animals as a basis for his theory of natural selection, he confessed his inability to explain the origin and causes of such variations. It may be that this admission spurred Mendel's efforts. At any rate, he set out to learn of the processes of reproduction that caused individuals to differ from one another. In a flash of inspiration, he saw that the path to a solu- (*Continued on page 156*)

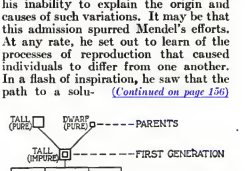


Diagram of the operation of the laws of heredity as discovered by Mendel in his experiments with tall and dwarf peas

Where men and millions strive to make America supreme in modern romance of rubber

Ford Gambles for Huge Stake

Establishes Rubber Plantation as Large as the States of Connecticut and Rhode Island Combined

By HYATT E. GIBSON

ROMANCE is unfolding anew in the drama of industry! What gold, diamonds, coal and oil used to be, rubber has become—the lure to adventure and a source of fabulous wealth.

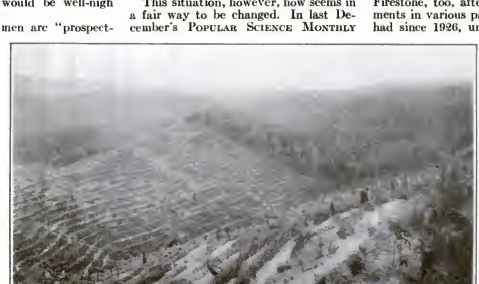
A new race of treasure hunters has arisen. Throughout a vast belt drawn around the waist of the earth, extending some 900 miles on each side of the equator, men are plunging into the jungles for the precious milky fluid that produces the rubber we know in thousands of everyday articles without which the conveniences of modern communication and transportation would be well-nigh impossible.

Elsewhere, other men are "prospecting" in the soil for plants to rival the rubber tree in the yield of sticky riches. Still others, in laboratories, are exploring for the chemical secrets of duplicating Nature's processes by creating man-made rubber.

In this treasure quest America is taking the lead. And with reason. We are using rubber in such enormously increasing quantities that experts have warned of a serious shortage by 1929 or 1930. Our automobiles are shod with nearly 100,000,000 tires, and the number is mounting. At least 30,000 different articles of rubber are being made in a thousand factories. Moreover, while we are using more rubber than any other nation and supplying the rest of the world with manufactured goods, we are almost entirely at the mercy of other nations for supplies of the raw product. Last year the United States consumed 380,000 tons of crude rubber, nearly two thirds of the world's total production. Yet of this we control less than four percent. The other ninety-six percent is largely in the hands of the British and the Dutch.

This situation, however, now seems in a fair way to be changed. In last December's POPULAR SCIENCE MONTHLY Thomas A. Edison told of his plans to produce substitute rubber from quick-growing shrubs and weeds, and of the belief he shares with Henry Ford and Harvey Firestone that a larger control of rubber supply is vital to the safety and peace of the nation.

And now comes Henry Ford with an announcement that he has received from the Brazilian Government a rubber concession of from 3,000,000 to 4,000,000 acres in the Amazon Valley of South America, the native home of the Para rubber tree. There he is planning rubber production on a vast scale. Harvey Firestone, too, after preliminary experiments in various parts of the world, has had since 1926, under lease in Liberia, Africa, 1,000,000 acres devoted to growing rubber trees. This project already is showing results. Production will begin in 1930, and Mr. Firestone believes his African plantations will become a factor in the world market by 1935.



All photographs by courtesy of U. S. Rubber Company

Clearing vast jungles of the Malay Peninsula for the establishment of rubber plantations, using seeds originally smuggled from South America. In a few years millions of acres have been planted

MEANWHILE America's pioneer in rubber growing, the United States Rubber Company, after seventeen years of experiment in cultivation, has enormously increased the yield

from rubber trees. Today its plantations, covering more than 134,000 acres in Sumatra and Malaya, have become the greatest single rubber estate in the world. C. B. Seger, president of the company, recently announced that these plantations are yielding 441 pounds an acre a year, as compared with the average yield of 350 pounds the world over. And he estimated that the ultimate yield from the latest planted areas will be a thousand pounds an acre annually.

Still another American venturer is the Goodyear Tire and Rubber Company, which, since 1916, has been developing plantations in Sumatra that today cover 5000 acres.

It is a real race for high stakes in a billion-dollar industry. No rush for Klondike gold nor stampede for Transvaal diamonds ever offered richer rewards or a greater challenge to daring and skill.

Never before has rubber prospecting been attempted on so vast a scale as that planned by Ford in his Brazilian concessions. Picture a wild, unknown land equal in area to the states of Connecticut and Rhode Island combined. Imagine fighting a way through the jungles, slashing trees and tangled undergrowth, and finally converting the wilderness into an immense, orderly farm of rubber. Here is a tract that is almost equal to the combined area of all the rubber plantations in the world. Under entire cultivation, yielding a thousand pounds to an acre, it would produce four billion pounds of rubber a year, enough for half a billion Ford tires!

RUBBER—but try to get it! For the region is perilous, almost trackless, ridden with fever and pestilence, infested with venomous reptiles and spiders and treacherous savages. To conquer it will require thousands of men, elaborate plans of campaign, and millions of dollars.

For months Ford has been carefully laying his plans. In 1926 he sent Professor Carl Larue of the University of Michigan to make preliminary surveys of the region, which lies on the Tapajos River, with the famed River of Doubt to the west and the Xingo River to the east. And now the work is to begin.

THE army that will be sent to fight the jungle will be led by skilled technical men—engineers, foresters, botanists, soil experts, chemists, railway and marine experts. Every task will be undertaken with scientific precision. First, settlements and supply bases will be established. These will be served by steamships of the Ford fleet, which will make regular trips to the district, and later perhaps by airplanes. Medical experts will enforce a widespread campaign of sanitation to safeguard against the danger of pestilence.

From the settlements the woodsmen will advance, leveling the forests. The planters will follow, cultivating the soil, fertilizing it, planting selected seeds. Each year, as the terms of the concession dictate, thousands of acres will be planted, until eventually the whole wilderness will be converted into a fortune in Hevea rubber trees.

Natives pour latex on wooden core and hold over fire. The rubber coagulates; waste evaporates

Bud grafting—one of the methods by which 27 strains of rubber trees with greater yield are produced

Still, it is all a gamble. It means enormous financial investment without hope of immediate return. From the time of planting, at least five years must elapse before the rubber trees can begin producing, and ten years before production can be brought to a profitable commercial basis. In that time, anything may happen. Who knows but that the world's rubber requirements will have been entirely altered, or that some more economical substitute for the natural product will have been discovered?

At the start, however, Ford at least has the advantage of valuable knowledge gained by other American pioneers in rubber growing. He can profit, for example, by the experiments of United States Rubber Company experts, who by seed selection and bud grafting have developed nearly thirty varieties of high-producing rubber trees, and who have vastly increased their milky yield by careful cultivation and scientific methods of tapping.

A rubber tree is ready to tap if no part of its trunk goes between the tines of a fork seven inches apart

As you know, crude rubber is obtained from the milky white juice, called latex, that flows from certain tropical trees and plants. Millions of these trees, of many varieties, grow in regions near the equator. Most important of all is the famous *Hevea brasiliensis*, or Para rubber tree. Until a little more than half a century ago the wild Para trees supplied all the world's rubber. Then certain British planters smuggled out seeds, which they tried in Kew Gardens, London, and in Ceylon to learn if the tree would flourish outside of Brazil. Successful in the experiments, they used more seeds to start the great plantations in the East Indies.

AT THE beginning of the present century, when the world's consumption of crude rubber was only 54,000 tons, most of it was still "wild rubber" from Brazil. Then the automobile entirely changed the picture. Tires required huge quantities of high quality rubber. The "wild rubber" gathered by South American natives who slashed the jungle trees haphazard was uneconomical and of uncertain quality. As a result, thousands of plantations covering millions of acres have sprung up in recent years in the Dutch and British East Indian colonies. Today the world's consumption has increased tenfold, and of the 600,000 tons of crude rubber produced annually, at least nine tenths now comes from cultivated trees of the tropical East.

And of this eighty percent goes into automobile tires. When you consider that it takes a year's milk from two full-grown Hevea rubber trees to produce enough rubber (*Continued on page 124*)

Fruits of Research In Scientific Fields

Advances and achievements in diverse scientific fields of research and invention, important for their relation to the daily affairs of life, are recorded each month in these pages.

Huge Machine Fights Cancer

LARGEST of weapons yet devised for war on disease is a gigantic new X-ray machine operated successfully for treatment of cancer in the research hospital of the University of Illinois in Chicago. It weighs four tons, occupies three large rooms, and cost about $500,000.

Using an electric pressure of 250,000 volts, it shoots the penetrating rays through the human body to destroy or retard cancerous growths. In eight to twelve minutes it is said to perform a treatment that formerly required one to two hours.

In the machine is the largest X-ray tube ever assembled, cooled by a constant flow of water. The tremendous voltage applied to the tube is supplied by transformers which "step up" ordinary electric light current. Delicate measuring instruments control the intensity of the ray.

Why People Wear Clothes

HOW came people to wear clothes? Was it because of modesty? Or immodesty, to make the body more mysterious and alluring? Or for adornment, or for protection from the elements? Each of these theories has been advanced. Now Dr. Knight Dunlap, professor of psychology in Johns Hopkins University, offers a new explanation. Primitive men and women first took to clothes, he says, to ward off flies and similar pests.

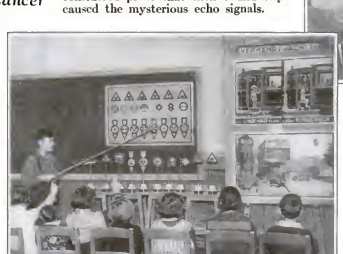
"Crawling and flying pests are with primitive man abundantly and very intimately," he says. "The most efficient protection is afforded by hanging strings, leaves, animals' tails, and similar articles that flap with the movements of the wearer. The fly protections used on domestic animals are exactly of the types of primitive human clothing which have baffled the anthropologists.

"Clothing itself is neither modest nor immodest," he added. "Any degree of clothing, as well as nudity, is perfectly modest when we become used to it."

Radio Echoes Are Explained

ONCE radio's big problem was to send the waves far enough. Now they often travel too far, around the earth and back again, causing an interfering echo. Occasionally they make several round trips, producing a series of echoes.

Recent experiments in Germany revealed that the echo signals always came at intervals of a seventh of a second. Since radio waves take just that time to encircle the globe, the experiments were considered proof that their round trips caused the mysterious echo signals.



Berlin school children in the elementary grades are taught the traffic and safety signals of the city. One acts as instructor and calls on the others to give the meanings of the various signs. Posters in the classroom also show safe and unsafe ways to board and leave street cars and cross streets, thus reducing the dangers to life and limb in large cities

Overcrowded Earth Foreseen

POPULATION is increasing so fast that unless drastic limitations are effected the world is headed for catastrophe and will have to hang out the "Standing Room Only" sign in sixty years.

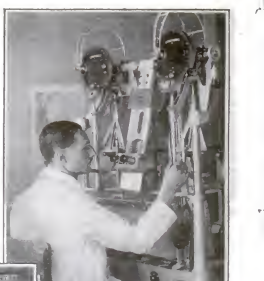
Such are the recent warnings of Edward Alsworth Ross, professor of sociology in the University of Wisconsin. During this year, he predicts, the people in the world will increase by 20,000,000, or at the rate of about 50,000 a day.

Greenland Yields New Storm Data

AFTER months of weather observations on the dreary Greenland ice cap, Prof. William H. Hobbs, head of the University of Michigan Greenland Expedition, returns more than ever convinced that the disasters from hurricanes which sweep down from the North upon Atlantic shipping lanes can eventually be averted by advance radio storm warnings.

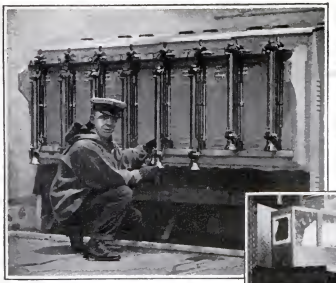
"I firmly believe," he says, "that Greenland is the birthplace of the terrific storms; that they are over Greenland a day or two before they are reported at sea.

"If we can substantiate this, then much can be accomplished through broadcasting storm warnings. We have only one station in Greenland. Much more could be accomplished if we had them at scattered points. If my theory is correct, no doubt that is what will happen, and the loss of life and property on the Atlantic may be greatly reduced. It should also be a help to aviation."



For an extensive air-mapping program, the U. S. Geological Survey is testing a new device for making contour maps. Two airplane photographs taken at once are mounted and illuminated, and through the double eyepiece the map maker sees them combined with the stereoscopic effect of depth. With the hills and valleys standing out plainly, it is easy to sketch lines in, using a point of known height as a guide. The system makes practicable mapping of territory inaccessible to surveyors

In experiments to develop a more satisfactory motor car headlight, investigators of the U. S. Bureau of Standards follow this test car and note the distances at which they can see the rectangular target when the various headlights are turned in their faces. Distances are measured with an Army range finder. H. H. Allen, of the Bureau, is adjusting the lights



United States cutters on ice patrol also test the temperature and salinity of ocean water of various regions and depths. The Greene-Bigelow bottles are attached at intervals to a wire that is let down with weights. An "electric messenger" makes them open, fill and record the temperature of the water. Then they are hauled up and put each in its proper place in the rack. Later the water is put in clean bottles and then sent off for saline analysis

Chemist-Made Personalities

BELIEF that man-made living beings eventually will be created artificially in the laboratory finds another supporter in Dr. Edwin E. Slosson, nationally known chemist, editor and author, who recently declared the chemist of the future will not only create life, but will find ways of altering personal character by chemical compounds.

"What we value as individuality—fascinating temperaments, charms of vivacity, and so on—all are due to definite hormones, some of which are already known as chemical compounds," he said. "Courage is not a matter of 'sand,' but of sugar. A variation of a few hundredths of one percent in the glucose of the blood may make the difference between cowardice and courage."

Even sex, he added, may be regarded as a chemical affair, which might be regulated by small amounts of certain compounds in the blood or food.

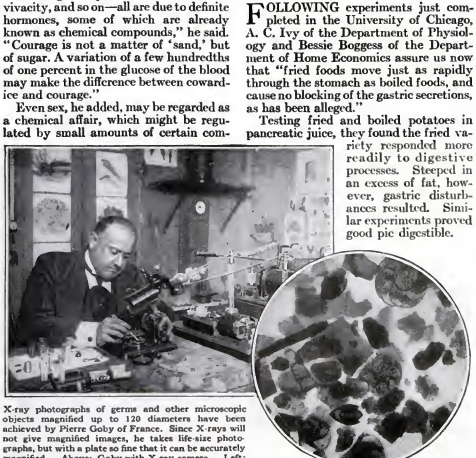
"Jacques Loeb," he said, "showed us frogs which had no father but a fatty acid, and he held artificial production of living beings from lifeless matter might sometime be achieved in the laboratory. The factors of heredity and the origin of species are chemical problems."

England's experts in agriculture and entomology now cooperate with farmers of the British colonies and dominions by breeding insects that make war on various crop pests. The insects are hatched in "nurseries" and then are sent abroad. Invaluable service has been rendered to New Zealand by this plan. The photo shows a "bug nursery," with insects in jars and boxes

Tests Vindicate Fried Food

FOLLOWING experiments just completed in the University of Chicago, A. C. Ivy of the Department of Physiology and Bessie Boggess of the Department of Home Economics assure us now that "fried foods move just as rapidly through the stomach as boiled foods, and cause no blocking of the gastric secretions, as has been alleged."

Testing fried and boiled potatoes in pancreatic juice, they found the fried variety responded more readily to digestive processes. Steeped in an excess of fat, however, gastric disturbances resulted. Similar experiments proved good pic digestible.



X-ray photographs of germs and other microscopic objects magnified up to 120 diameters have been achieved by Pierre Goby of France. Since X-rays will not give magnified images, he takes life-size photographs, but with a plate so fine that it can be accurately magnified. Above: Goby with X-ray camera. Left: microörganisms in grain of sand magnified 50 times

Medicine Gains New Ground in Tireless War on Disease

A NEW English antiseptic called "monasol," derived from coal tar, is hailed as a revolutionary aid in medicine and surgery. It can be swallowed without harm and can even be injected into the blood through the veins.

Another important medical discovery is claimed by the Ringgold Chemical Laboratory in Hamburg, Germany. It consists of testing blood taken from the ear lobe or finger. The condition of the white corpuscles indicate, it is said, presence of cancer years before other symptoms appear.

New facts about colds were given recently by Dr. Volney S. Cheney, medical director of a large Chicago packing firm. After eleven years' study, he declared colds are not infectious, but are caused largely by overeating, lack of exercise, loss of sleep and mental strain.

The average American family pays $60 a year for medical service, according to latest estimates. Every new step in medical research saves us money.

X-Rays May Beat the Cotton Pests

DR. H. J. MULLER, of the University of Texas, who discovered recently that the use of X-rays speed the processes of evolution in plants and animals, at the same time encouraging new varieties, will now employ X-rays in efforts to breed a new kind of cotton to grow so fast that the boll weevils will have no chance to damage it. University authorities have instructed him to devote his entire time to the work in hope of circumventing the insect pests.

Apples that bear the year after planting, strawberries the year around, and raspberries growing where they never grew before are other new achievements of plant wizards, reported by George M. Darrow, of the U. S. Bureau of Plant Industry.

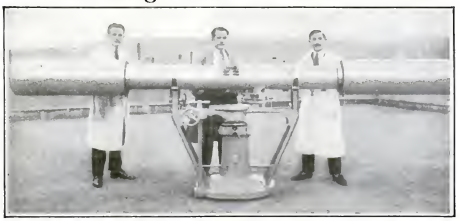
Earthquakes Laid to Moon

SEVERE earthquake shocks in recent months have aroused more than usual interest in seeking ways to ward off disaster from them.

R. M. Wilson, temporarily in charge of the Hawaiian Volcano Observatory, says that when the moon is in its first or last quarter, earthquakes are unusually plentiful. He believes the answer may be found in the gravitational pull of the moon on the earth's rocks.

Earthquake alarm bells to sound warnings automatically a few hours in advance of a shock are proposed by John W. Evans, British seismologist. The suggestion is based on the fact that in great earthquakes the actual tremor has been preceded by a slight rising of the ground that would be sufficient to ring a bell.

Giant Range Finder Covers 20 Miles



Sighting glasses in ends of this huge range finder are trained by mirrors through the middle opening on objects 20 miles away, fixing their exact distance. It can be used on land and ships

AS FAR away as twenty miles, an object's distance is accurately determined by a new giant among range finders. Within its thirteen-foot tube is a sensitive optical apparatus through which, as in smaller instruments of this kind, two sighting glasses at the ends are trained upon a far-away ship or other point of interest. By the difference in the angles at which they must be pointed, the exact distance to the vessel is automatically indicated. Accuracy is improved by making the device large.

For use in coast stations, this huge range finder, recently demonstrated by its Paris maker, is mounted on a tripod. War vessels would install it in a revolving turret similar to a gun turret, so that it could be pointed in any direction.

New Sugar Cane Delicacy

SO POPULAR has cane cream, a new sugar product developed by the U.S. Bureau of Chemistry, become in the South that the Government is now introducing it to Northern cookery experts. The delicacy is a dark brown, thick, sirupy cream. Its taste is midway between that of molasses and Canadian maple cream, a spread made from maple sugar. Unlike molasses, the left-over juice of sugar manufacture, cane cream is the whole juice with none of the sugar removed.

"Fingerprinting" Muffins

"FINGERPRINTING" muffins to identify them was the novel expedient of Miss Mary Little, a Tuscaloosa, Ala., teacher, when, to win a Master of Arts degree, she recently conducted an elaborate study of ways to make them. Hundreds of muffins, some good and others failures, had to be preserved and distinguished from each other. Miss Little smeared a cross section of each with mimeograph ink, taking its print on paper. Not two muffins, she found, gave the same "fingerprints."

Artificial Rubber Nearer

ARTIFICIAL production of rubber is brought a step nearer by a recent chemical discovery at the University of Notre Dame. Two chemists there have found a new catalyst (a substance that promotes a chemical reaction without itself taking part in it) that will aid in combining rubber's chemical constituents.

Cobwebs Made by Machine

MORE cobwebs than a spider could spin in a week are produced in an instant by a "mechanical spider" invented at a Los Angeles motion picture studio. It covers shrubbery with misty webs, as shown below, to add realism to the scenes. A jet of liquid rubber spurts from the device and solidifies as a tiny fan blows it into a million strands. The webs are said to be indistinguishable from the genuine insect product.

To make cobwebs on bushes in motion picture scenes, a machine spurts liquid rubber and fans it into myriad tiny strands

Any Questions?

WHENEVER possible, POPULAR SCIENCE MONTHLY is glad to answer questions on subjects within its field. Queries, with stamped, self-addressed envelopes inclosed, should be sent to Information Department, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York.

Earth Rotates More Slowly Each Day, Says Astronomer

EACH day on earth, from noon to noon, is a little shorter than the last, Sir Frank Dyson, Astronomer Royal, recently declared in an address in London, England. Latest investigations by two young Cambridge astronomers show that the earth is slowing down, he said. In a hundred years, according to their figures, a day will be one thousandth of a second shorter. The tides' frictional drag is blamed; eventually it may bring the earth to a standstill. At the present rate, however, this would not happen before at least 8,000,000,000 more years.

New Mail Box Weighs Letter

IF TESTS now being conducted at Leipsic, Germany, prove it successful, a new automatic mail box that weighs and stamps letters will come into general use in that country. The sender drops in his missive and then inserts coins to pay the postage. He pulls a lever, and an inked stamp within prints on the letter a mark that shows the postage has been paid.

Fokker Pictures New Planes

FUTURE airplanes will have power plants completely inclosed in an engine room, says Anthony H. G. Fokker, noted aircraft builder. He recently told New York City engineers: "The airplanes we have now are loaded up outside with all sorts of things which should not be there."

Fokker pictures tomorrow's plane with four or more engines, each connected by a clutch to the propeller. If one failed, the engineer would release its clutch and repair it, using others meanwhile.

Only Cactus Apple Orchard

AT THE only cactus apple orchard in the United States, near San Fernando, Calif., huge quantities of this remarkable delicacy are grown for markets throughout the country. Their watery meat, which has a pulpy sweetness, is used to make jellies, preserves and candy; or the apples may be eaten just as they are plucked. Each acre produces 500 to 600 boxes of the rare fruit.

Harvesters at the only cactus apple orchard in this country, at San Fernando, Calif. Here each acre produces 500 to 600 boxes of the fruit, which goes mostly into candy and preserves

Priest's Liquid Air Blast Mightier Than Dynamite

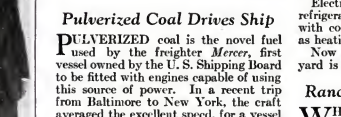
A GERMAN priest has just perfected for practical use an explosive that is said to be more destructive and less hazardous to use than dynamite. It has been known that carbon powders such as soot and coal dust form powerful explosives when impregnated with liquid air; now the Rev. Johann Julius Braun, of Marbach, Germany, has eliminated the danger that barred their use.

Alum or borax added to the mixture, Father Braun finds, will prevent such accidental spontaneous explosions as two which occurred in the course of his experiments. To minimize danger of predetonation when a mercury cap detonator is attached to the cartridge, he has invented an igniter that works only when the liquid air is added a few moments before use. The compound loses its explosive power after thirty minutes and is safe to handle again.

One-Man Town Enjoys Boom

WHEN they raised taxes in Wooster, Ohio, T. E. Rice built himself another town. He took his wife and son with him to the country, where they now operate the highway village of Riceland, Ohio. It boasts a good hotel, restaurant, piano store, automobile shop and grocery —all under one roof. Gas filling stations and an adjoining garage are added attractions, while a nine-hole golf course near by completes the one-man town. Passers-by on the Lincoln Highway between Wooster and Massilon stop at Riceland to yield it a business of more than $50,000 a year.

T. E. Rice, who quit Wooster, O., because of a tax increase and now runs his own town. This gas station is only one of his industries



The town of Riceland, O. With only one building, it houses many enterprises

Woman Discovers Better Steel Process

TWELVE years of research taught Madame De Silva, an American woman of English descent, a new process of making steel. The excellent quality of the metal she makes is due to the addition of titanium-bearing sand, which she obtains from all parts of the world. At her Sheffield, England, factory, of which she is business manager, many types of steel products are made. The picture shows Madame De Silva demonstrating the flexibility and strength of her steel.

Madame De Silva proves strength and flexibility of steel she makes by a process that employs titanium-bearing sand. At the left are some products of her plant at Sheffield, Eng.

"Glass" Rolls Up Like Cloth

LIKE cloth is a new glass substitute that is said to be weatherproof and translucent. It is sold in rolls, and also by the yard, to be used for garages, barns and temporary buildings of many sorts. The maker declares that it admits the healthful invisible ultra-violet rays of the sun; this feature would make it useful for sun porches, letting in the rays while insuring privacy. Its flexibility and unbreakability are, however, called its chief advantages.

Pulverized Coal Drives Ship

PULVERIZED coal is the novel fuel used by the freighter *Mercer*, first vessel owned by the U. S. Shipping Board to be fitted with engines capable of using this source of power. In a recent trip from Baltimore to New York, the craft averaged the excellent speed, for a vessel of its type, of 10.8 knots. The most outstanding feature of the ship's performance with the powdered fuel, however, was its great flexibility, according to Carl J. Jefferson, Chairman of the Fuel Conservation Committee of the Shipping Board. It behaved well under both light and heavy loads.

Alpine Cosmic Rays Studied

TO CHECK up on the "cosmic rays" discovered not long ago by Prof. R. A. Millikan, noted American physicist, Swiss investigators have braved the bitter cold of the Alps. The students, under Prof. Dr. De Salis, were dressed like polar explorers and slept in fur-lined bags near the summit of the Moench and the Jungfraujoch, the first peak 13,000 feet above sea level. Here they set up quartz-wire electrometers, delicate electric instruments to detect and measure the little-understood rays.

These mysterious vibrations, observed by Millikan on the highest slopes of Mount Whitney, Calif., are more penetrating and of higher frequency than X-rays. They are thought to come from the stars, but their cause is unknown.

Electric Liner Sets U. S. Record

ALL American records went by the board with the recent launching at Newport News, Va., of the 22,000-ton S. S. *California*, largest commercial steamship ever built in the United States. The mighty vessel is also the largest electric-driven passenger ship in the world; her generators produce enough power to run eight Panama Canals. Steam turbines run the dynamos. With electric power for the propellers, an engineer can control the huge ship with three simple levers.

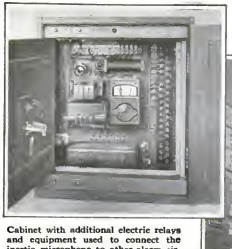
Electricity will be used for cooking and refrigerating food and ventilating cabins with cool air in tropic latitudes as well as heating them in cold weather.

Now under construction at the same yard is a duplicate sister ship.

Ranches in Arctic Proposed

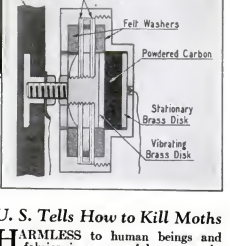
WHEN the pressure of life in temperate climes grows too high, move to the Arctic. That was the recent amazing suggestion of Dr. Rudmose-Brown in his presidential address to the Section of Geography at Leeds, England. In huge unoccupied areas such as Spitzbergen, the northern Canadian Islands, and parts of Alaska, Canada, and Siberia, man could raise herds of reindeer and musk oxen and obtain an almost unlimited supply of meat and hides. Transport north is comparatively easy now; scurvy, dread disease, is conquered. By radio the colonists would talk with the rest of the world; and live meanwhile, says Dr. Rudmose-Brown, with no great hardships in the beautiful Arctic valleys.

Submarine Detector Bank Burglar Alarm



Cabinet with additional electric relays and equipment used to connect the inertia microphone to other alarm circuits, such as those of the police or private detective or protective agencies

The inertia microphone with its relays, mounted inside a bank vault, ready to respond and send an alarm if a burglar's drill or blowtorch attacks any part of the vault's wall



A cross section of the inertia microphone, showing the essential parts by which it senses vibrations when the vault wall is attacked by cracksmen and by electric relays sends out an alarm

WHERE elaborate alarm systems may fail to protect a bank's vaults against the skillful burglar, the newest invention, an inconspicuous little metal "can," will call the police and result in the cracksman's capture. It contains an inertia microphone, used in warfare as a submarine detector, and now science's latest weapon against the safe-breaker.

When the intruder turns his whirring drill upon the steel door of a vault, the vibrations actuate this sensitive electric device and turns in an alarm. Even the sputtering of burning metal under a blowtorch will operate the apparatus.

Its principle is similar to that of the telephone, in which the air vibrations of your voice alter the passing of electricity by alternately compressing and releasing a small chamber filled with carbon granules that transmits the current. The consequent pulsating current reproduces your voice at the other end of the wire.

In the inertia microphone, as developed by the Bell Telephone Laboratories for use as a burglar alarm, the whole inside of the transmitter is fixed to the vault wall and vibrates with it. The inner shaft terminates in a brass disk facing a similar one on the outer shell. Between the two is the electricity-conducting carbon. Flexible mica disks serve as springs to hang the free outer shell on the shaft.

When the wall is attacked, the whole inner shaft vibrates, but the heavy shell outside remains practically stationary by virtue of its sluggishness or inertia. Hence, as in the telephone, the carbon is alternately compressed and released; but instead of reproducing a voice, the resulting pulsating current is made to operate a relay that sounds an alarm.

By properly adjusting the action of the mica disks, they are made to respond only to such vibrations as indicate a thief at work, and are shielded from ordinary shaking, such as that caused by vehicles passing in the street.

Typewriter for Sheet Music

WITH the aid of a recently invented machine, you can type off a popular song as easily as a letter—if your mind runs that way. Maestro Ferretto, a musician of Milan, Italy, has just devised a novel form of typewriter that turns a blank sheet of paper into a complete musical score. It writes the lines of the staff, the musical notes themselves with all accidentals and marks, and even the accompanying words! An electric motor operates the device.

You Breathe Pounds of Dust

IN A year's time the average American inhales in the air he breathes five times his weight in dust, according to a recent estimate. However, air-purifying apparatus is now doing much to reduce this alarming total, particularly in industrial occupations.

Device Notes Speech Flaws

CORRECT enunciation is soon learned with the aid of the telegraphone, a new device recently used, as illustrated below, in public speaking classes at the University of Southern California to enable students to hear themselves talk. Like a dictaphone, it records and reproduces the voice, but the record is so perfected that when it is played over it reveals any imperfections of speech such as indistinct tone or lisping.

The public speaking student on the left is criticising *her* companion's enunciation, and the telegraphone makes a record to test her criticism

U. S. Tells How to Kill Moths

HARMLESS to human beings and fabrics is a powerful new moth-killing preparation developed by Government experts, R. T. Cotton of the Bureau of Entomology and R. C. Roark of the Bureau of Chemistry and Soils. The solution should be suspended in an air-tight closet or chest above the clothes. The vapors descend and kill all moths.

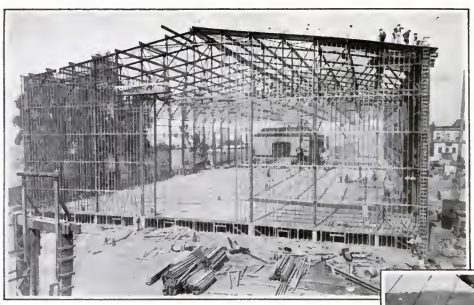
Anyone can mix the fumigant, which consists of one part by volume of carbon tetrachloride to three parts of ethylene dichloride. The first liquid is obtainable at drug stores; the second may have to be purchased from a chemical supply house. Both are inexpensive.

Other Government tests show that certain marketed "mothproofing" solutions immunize fabrics against moths if used to wet the cloth through while it is in the whole piece; many manufacturers have installed machinery for the purpose.

What Reward for Scientists?

SHOULD the inventor of a new electric airplane beacon, or the creator of an improved X-ray tube, share his profits with the scientist whose theories and formulas made the invention possible? John H. Wigmore, Dean of the Faculty of Law at Northwestern University, considers this a coming theme of importance, and the Faculty of Law is seeking to interest lawyers in the question.

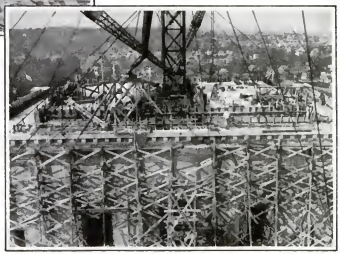
Whether the patent or copyright laws should be extended to give a quasi-patent right to the discoverer of a principle of science is a subject in which they invite legal men to submit their views in a $1000 prize essay contest.



Largest Block of Concrete In World for Temple Roof

TO FORM the roof of the huge George Washington Masonic National Memorial Temple, at Alexandria, Va., workmen recently poured the largest one-piece concrete slab in the world. Seventy-eight feet eight inches wide, 110 feet long and more than three feet thick, it rests upon massive beams and columns of reinforced concrete. The photograph below shows the pouring operations.

The great slab itself contains 933 cubic yards of concrete. The beams on which it rests are seventy-two feet long and fourteen and a half feet deep. The span of the beams is broken by eight granite columns forty feet high.



Concrete is sliding down the chute (at top, left center) in pouring of a single slab to make the roof of the Alexandria, Va., Masonic Temple

New Film Studio Dwarfs Others

LARGEST in the world is the tremendous De Mille studio being built at Hollywood, Calif., surpassing its nearest competitor, in Berlin. The $200,000 stage, almost big enough for a football game, has 43,680 square feet.

Magnetic Alloy for Telephones

NOW permalloy, the highly responsive magnetic alloy of nickel and iron developed by the Bell Telephone Laboratories for deep-sea cables, has proved its use in a skillful adaptation to telephone equipment. Metallurgical engineers of the Western Electric Company assisted in seeking a way to embrittle the alloy, much more susceptible to magnetization than iron, so that it might be ground to a powder and used to mold cores for electrical telephone coils.

At last they succeeded; "loading" coils whose cores are made from the new alloy have proved exceptionally efficient. They are also exceedingly compact—one third the size of the old iron-core coils—and are more economical to manufacture.

760 Eggs Laid Every Second

DID you know that in the minute or so it takes you to eat your breakfast egg, some 50,000 more are laid somewhere in the United States? Twenty-four billion eggs a year, or about 760 a second, is the present laying record of American hens, the U. S. Department of Agriculture recently announced.

By reaching this new mark, poultry now represents about sixteen percent of the total value of all livestock and its various products.

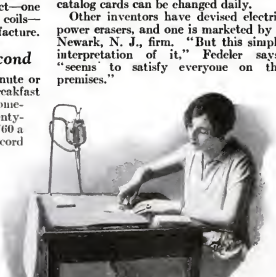
Slot Machine Sells Medicine

WHEN the busy Londoner feels the need of something to ease his nerves or to cure a cold, he may find it on the nearest street corner; for a shilling-in-the-slot machine selling medicine has recently appeared on the streets of the British metropolis. The machines will soon be ready to supply the impatient purchaser anything from pills to hair tonic, reports say.

Hair Clipper Erases Ink.

BY REMODELING a hair clipping machine, New York's Public Library has just provided itself with an electric eraser that speeds alterations of records. When clerks faced a volume of revising and correcting, the engineer of the building, John H. Fedeler, proposed this ingenious expedient to replace the hand rubber. Now, with the whirring eraser disk, four or five hundred catalog cards can be changed daily.

Other inventors have devised electric power erasers, and one is marketed by a Newark, N. J., firm. "But this simple interpretation of it," Fedeler says, "seems to satisfy everyone on the premises."



Courtesy of Edison Monthly

An electric hair clipping machine converted into a rotary eraser, being used in the revision of records in the New York Public Library

Luminous Night Golf Balls

ALL-NIGHT golf, played with luminous balls, may be the fashion one of these days. Recently spectators in a New York City park saw Millard J. Bloomer, a New York experimenter, unwrap from tinfoil eight balls that glowed in the twilight with a greenish yellow phosphorescence. Swinging a club, he sent each ball for a long drive, whose light-streaked course could be as plainly followed as that of a tracer bullet. When Bloomer set out to collect the balls he found four shining like mammoth glow-worms in the fairway, while the others revealed their hiding-places amid bushes and leaves. The round-up took but six minutes.

A chemist at Columbia University is seeking to improve the secret composition with which the balls are coated, Bloomer said; for now they lose their light after eight or ten minutes' exposure to the air.

Beds Tested Scientifically

BEDDING of all types came in for scientific investigation recently at the hands of Dr. H. M. Johnson, of the Simmons Fellowship for the Study of Sleep. Vertical coil box springs were best, he concluded; for the mattress, good cotton filling or horsehair. An innovation found excellent was a mattress with light coil springs inside.

Recent investigations show the deepest, most restful sleep is concentrated into less than three hours.

Inventive Oddities And Utilities

Clockwork Runs Razor

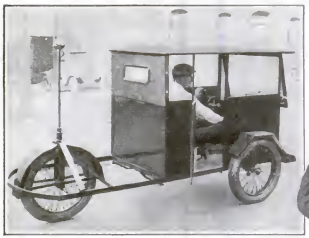
When the spring is wound the blade in a razor invented in England oscillates from side to side in a metal holder. The user simply directs it here and there at will over his face and emerges clean-shaven. The holder also serves as a safety guard, says its inventor

One-Wheel Skates

One roller is centered beneath the arch of each foot by Maxwell Stoops, English inventor, who says that more natural balance results

Valve Grinder Saves Labor

This valve grinder, adopted by the Government, of cast aluminum and steel, has an oscillating motion. An auto power pump drives it. R. E. Veltum, Eugene, Ore., invented it



"Athletic Automobile" Driven by Hand

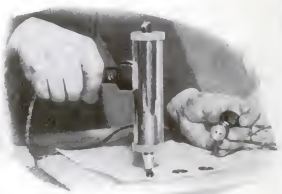
To increase the development of his arm and back muscles a wrestler is touring the United States with a strange-looking auto driven by chain and sprockets. The operator supplies the motive power with his hands and steers with his feet

Shears That Don't Tire

The shears at the left are operated by a single handle, connected by a hinge and spring to the other blade. The spring reopens the shears' blades after each stroke

Electrical "Normalizing" or Self-Massaging Machine

Somewhat resembling a physician's examining table, this device is composed of a series of padded blocks on which the subject lies. When current is turned on the sections roll from side to side in alternate directions, thereby massaging the body



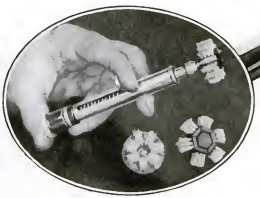
Machine Drops Wax Seal on Your Letter

Insert a stick of sealing wax in the top of a new electric heating device and the cylindrical reservoir fills immediately with molten wax, which you can drop in desired quantities. It can be operated with one hand and avoids the messy use of matches. C. Johnson, an English major, invented this handy office device

Shaving by Clockwork—Curing Seasickness with Gas—A Dry Land Boat—A Whirling Toothbrush—Many and Varied Novelties

New Pipe Traps the Juice

Cutting a slot in the bowl of a pipe, an English inventor has inserted a pivoted disk with holes to permit passage of smoke alone. Swinging disk ejects paper pellet it holds, which traps moisture

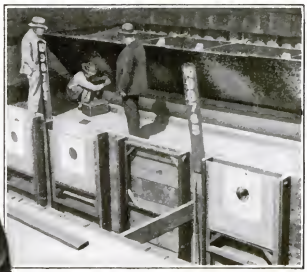


Rotary Toothbrush

When a new rotary brush is held against the teeth, pressure at the other end makes the bristles whirl. Rapid manipulation of the spring lever increases the speed

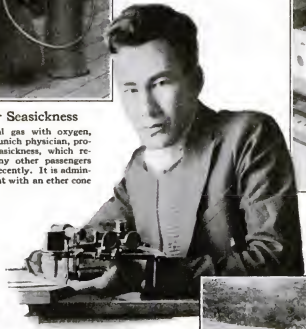
Gas Cure for Seasickness

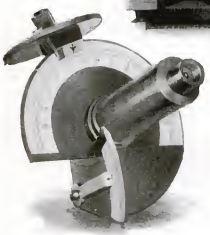
By mixing a special gas with oxygen, Dr. F. Dammert, Munich physician, provides a cure for seasickness, which relieved him and many other passengers coming to America recently. It is administered to the patient with an ether cone



Lead Bullets Made Over and Used Again

On their pistol range the Los Angeles police have devised behind the targets a steel bulkhead which deflects bullets into a trough. They are salvaged, melted up, cast and fired again. The U. S. Army may adopt the idea when building new ranges



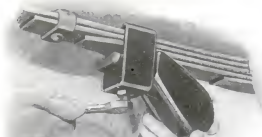


Substitute for Sextant

Instead of requiring calculations by mathematical formulas, as does the ordinary sextant, the instrument above, invented by H. B. Kaster, of California University, enables the observer's latitude and longitude to be read directly

Famous English Oarsman Rows in "Boat" on Dry Land

For practice at his home in Sussex, England, Perry, the famous oarsman, has constructed a tank in which he operates a twelve-foot oar. His "boat" is a wooden box fixed securely beside the tank, whose metal rim, high where required, prevents escape of any water. The size of the tank provides the maximum "stretch" for the rower



New Kind of Shock Absorber

MOTORISTS who wish to take some of the bumps out of a day's ride may now avail themselves of a convenient new shock absorber, attached in a few moments to the spring. It is said to arrest the vibration and jolts caused by irregularities in the road, without interfering with the spring's natural action. In addition to comfort, greater road traction, easier steering, longer tire mileage and better braking are said to result, since the wheels hold the road instead of flying up at every jar. The device differs somewhat from the conventional shock absorbers in that a hinged weight is used to check excessive spring action.

Curbside Telephone Booths

PHONE service is brought directly to your car seat by a handy new type of curbside booth. For the use of passing motorists, a Pasadena, Calif., hotel recently installed the new phones on the highway outside its doors. It reports that tourists are quick to take advantage of the convenience; important telephone calls they forgot to make are accomplished in a moment without leaving their cars.

So popular is the innovation that other curbside booths are being erected throughout southern California. They are expected to eliminate delays in hunting for an indoor telephone.

Telephoning while motoring is simple with the roadside telephones in southern California. All you need do is drive up to one of the booths, lift out the instrument, and call your number

Last Comet's Core Tiniest on Record

SMALLER than the nucleus of any comet ever before observed was the core of the Pons-Winnecke comet that passed near the earth last summer. According to the recent announcement of Dr. V. M. Slipher, director of the Lowell Observatory at Flagstaff, Ariz., a comparison of its apparent size with that of the moons of Jupiter, whose actual size and distance are known, showed it to be probably not more than two or three miles in diameter. Through the most powerful telescopes, he had observed, it was impossible to distinguish the nucleus from stars except by its motion.

Weather Gaged Weeks Ahead

SCIENTIFIC weather forecasts weeks, instead of days, in advance, have already given encouraging results, according to H. H. Clayton, the noted meteorologist. Last year, he announced recently, his advance estimates of prevailing monthly temperatures proved to be correct for all except the two months of February and August.

The new system of weather prophecy is being developed from the recent discovery that the earth's climate is closely related with the sun's activity as indicated by sun spots, and varies in certain definite cycles whose period has been determined largely through the work of the Smithsonian Institution.

New Guards Shield People Car Passes

COURTEOUS motorists in Europe are adopting new splash guards to avoid showering pedestrians with mud or slush as they pass. The devices fit close to the wheels, near the ground, to stop flying dirt and water. They are mounted on the axles in such a way as to remain stationary while the wheels revolve. In Europe many roads and even city streets are paved with cobblestones, from which cars bouncing over them spurt quantities of mud.

Leadville Is Highest Town; Brawley, Calif., the Lowest

THE highest and lowest towns in the United States are disclosed by a recent census. Leadville, Colo., first a gold mining camp and then a silver, zinc, and copper source, tops the country with its altitude of 10,185 feet above sea level. Brawley, Calif., a fruit-growing town in the Imperial Valley, is 112 feet below sea level. Each has approximately 5000 inhabitants.

Scientific "Divining Rods"

HOW the modern "divining rods" of science can actually detect buried treasures of useful ores was recently told by Dr. Max Mason, president of the University of Chicago. Ingenious new instruments send special forms of sound waves, or electric or magnetic impulses, into the earth, and through their sensitive recorders reveal what lies beneath. Other devices measure so delicately the pull of the earth's gravity that they can detect a heavy mass of valuable ore.

None of these devices, Dr. Mason emphasized, bore the faintest resemblance to the "divining rods" long used by charlatans to fool the ignorant.

The Brain Two Feet Square

SPREAD out, the cortex, or outer layer of gray matter, of a man's brain would cover more than two square feet. It contains 9,200,000,000 nerve cells.

Know Your Car

THE question of what oil to use in the crank case during cold weather is most important, but you will also find that using the correct cold weather lubricant in the transmission and rear end will save wear on the working surfaces in these parts and make gear shifting easier.

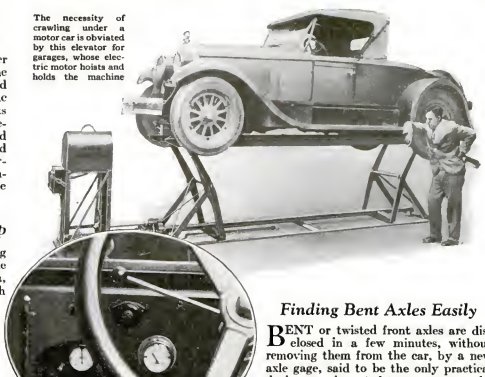
The correct grade of oil for the crank case depends on whether you are careful to keep the motor at normal summer running temperature by covering a sufficient portion of the radiator, or whether you neglect this precaution. If you keep the motor as warm as in summer, you should use the same grade of oil as in hot weather, but you must be careful about starting a cold motor. Let it idle slowly for several minutes until the oil warms up and starts to flow. Racing a cold motor causes excessive wear on every working surface.

If you insist on allowing the motor to run cold and on racing it to warm it up quickly, fill the crank case with oil that will flow at zero temperature.

Have your transmission and rear end flushed out and filled with a fairly light transmission oil in order to eliminate difficulty in shifting gears.

Elevator Lifts Broken Car; You Needn't Crawl Under

HERE'S the modern way to get under a car! Instead of crawling into the cramped space between the chassis and the garage floor, a mechanic runs the machine onto a novel elevator and starts the electric motor that operates the device. In a jiffy the automobile is hoisted off the floor and locked in an elevated position that affords ample room for several men to work beneath it. A Pennsylvania concern recently introduced the ingenious device.



The necessity of crawling under a motor car is obviated by this elevator for garages, whose electric motor hoists and holds the machine

Climate Unvaried 7 Miles Up

RECENT observations with sounding balloons show that the same climate exists above the United States, Russia, England, and the equator, if you go high enough, according to L. T. Samuels, of the U. S. Weather Bureau. Recording instruments sent aloft on pilotless balloons and later recovered indicate that above a height of seven miles the temperature is the same the world over, roughly seventy degrees below zero.

"Radium Bank" Projected

A SIXTH of an ounce of radium, the most precious substance on earth, may be made available to physicians throughout Australia by a proposed "radium bank" that would keep and lend its diminutive stores to any doctors qualified to use it for treatments.

How Much Do You Know of the World You Live In?

TEST your knowledge with these questions, chosen from hundreds sent in by readers. Correct answers are on page 134.

1. Where is coal mined in the Arctic?
2. What river is called "the boat destroyer"?
3. What is the Isle of Pines?
4. Where is the greatest pearl fishery in America?
5. What United States city was once a Russian capital?
6. Where do fish help plant mussel shells for buttons?
7. Where are automobile roads made of straw?
8. Where do the trade winds blow?
9. Which is the oldest grain?
10. What is the only work of man that could be seen from the moon?
11. Where do ants build hills forty feet high?
12. How do the African pygmies kill elephants?

Guide for Motorists in Fog

ARE you on the road, or off it? Lest you drive into a ditch, on some foggy day when clear vision is impossible, this remarkable new device for your dashboard, known as a "roadometer," tells when you are approaching the edge of the highway. When this happens, the needle on the dial swings over to warn of danger. The device contains a level, and depends for its operation on the principle that most highways are graded to curve upward at the center and slope off at the sides. It is the product of an English inventor, who claims it will eliminate most of the accidents due to thick fog.

Finding Bent Axles Easily

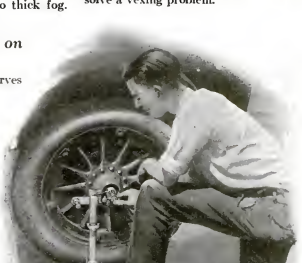
BENT or twisted front axles are disclosed in a few minutes, without removing them from the car, by a new axle gage, said to be the only practical device ever invented to measure on the car, in degrees, the axle's tilt. The entire operation of testing one end of the axle requires less than five minutes.

To find the cause of the steering wheel's "shimmy," for instance, you remove the hub cap, as shown below, and mark a point on the axle's spindle, setting the gage to the exact height from the floor of the point you have marked. Then turn the front wheel, resetting the gage for the new height of the axle caused by the tilt. Then you can compare the difference, registered in degrees, with a manufacturer's chart showing the original adjustment. Any discrepancy will indicate you have a bent or twisted axle. The trueness of the rear axle can also be checked with this apparatus. The device has been hailed by many mechanics and automotive experts as an easy way to solve a vexing problem.

Dirigible Can Land on Earth or Water

EITHER water or land serves as a landing field for the latest nonrigid airship, just completed at the Naval Air Station, Lakehurst, N. J. The amphibian dirigible, said to be the first of its kind in this country, has a boat-type control car, two 180-horsepower Wright engines that give it a speed of fifty knots, and a gas bag that holds 200,000 cubic feet of helium. It can fly for twenty-five hours without descending.

The novel aircraft, which is officially known as the *J-4*, will be used as a training ship for dirigible crews. Its sister ship, the *J-3*, is now in commission at Lakehurst.



The new way to find if an axle is bent. The gage is set by the spindle. Then turn the wheel and see if it agrees properly with the spindle figure

New Gas Detector to Protect Miners

Exploring a mine with the electric detector for the dangerous fire damp that causes explosions. The gas increases the heat of the electric coil in the detector on the end of the stick and moves the pointer on the connected dial

FIRE damp—the explosive gas that is the dread of coal miners —is detected by electricity in a new sensitive instrument just perfected. In recent tests it showed its ability to reveal slight traces of methane, the principal ingredient of fire damp, long before enough has accumulated to cause an explosion.

The apparatus, easily portable, consists of the detector itself, mounted on a stick to explore overhead corners, and the small battery that supplies the electricity. A needle indicates on a dial the amount of fire damp. Five percent will cause a blast.

The standard method heretofore of detecting methane was with an oil lantern, the Davy safety lamp, whose blue flame lengthens slightly in the presence of methane. In the electric detector a platinum coil heated by electricity becomes hotter when in contact with fire damp, and the altered electric current caused by its changed electrical resistance is indicated on the dial. According to E. K. Judd, mine technician, detectors placed at fixed points in the mine will automatically ring alarms.

Fire damp detector, battery box, and dial. Fire damp makes the detector increase the amount of electricity taken from the battery, which is recorded on the dial

Lead Varies in Its Weight

NOW the familiar phrase "heavy as lead" might evoke the response, "Which kind of lead?" Recent experiments reveal that the metal, long regarded by chemists as an invariable element, may be made up of three or more kinds whose weights vary.

When radium goes through its surprising changes and finally ends as lead, chemists have been at a loss to explain why its weight differs from that of the metal we mine. To solve the problem, Dr. F. W. Aston, British physicist, caused ordinary lead atoms to fly between the poles of a powerful magnet. This sorted them out according to weight, and Dr. Aston had at least three different kinds of lead, and possibly more. Ordinary lead, he proposes, is a mixture of about fifty percent of the heaviest kind and about twenty-five percent each of the two others.

New Lock Foils Bank Thieves

THROUGH a new time lock for bank vaults that allows the door to open only after a predetermined time has followed the unlocking of the combination, bandits may be foiled. Even an authorized official must wait while the hidden machinery is whirring. The device can be set to open the vault at any time from ten minutes to seventy-two hours after the knobs and dials have been twirled to their correct combination. The same timebination principle, as it is called, can be applied to chests used to transport money from one bank to another.

Police officials agree that many bank robberies could be prevented if it took just a few minutes longer for the burglars to gain entrance to the vault.

An Ocean of Rain Every Day

EACH day sufficient rain falls upon the earth, official figures show, to fill a reservoir 400 miles square to a depth of ten feet. It descends at the goodly rate of sixteen million tons a second.

Speed of Light Decreases, French Astronomer Finds

IS LIGHT as speedy a thing as it ever was, still fast enough to dart around the earth seven times a second, or is it slowing down? That its speed may be, at least, gradually decreasing is the amazing suggestion of M. E. J. Gheury de Bray, French astronomer, who cites the various determinations of light's velocity made from 1849 to the present.

Of the nine measurements, all but the first two—which may have been inaccurate because of faulty apparatus—seem to show a consistent decrease of speed; if they are a true indication, M. De Bray declares, the decrease is nearly three miles a second each year. The last figure, found last year by Dr. A. A. Michelson, University of Chicago, was 186,284 miles a second, considerably less than that observed fifty years ago. If the new determination he is now working on proves lower yet, the theory will have new support. Though such a variation would be of little importance to the layman, it would profoundly modify the ideas of theoretical physics and of relativity in particular.

How City's Dust Dims Lights

THREE weeks' dust in a modern city will lower an electric light's brilliancy by ten percent, according to H. Lingenfelser, German illuminating engineer. He finds that for maximum efficiency lamps and reflectors should be cleaned every ten days, with monthly use of soap and water. The wages of such a light-tender in an industrial establishment are fully repaid by the light saved.

Fire Hose Spares Furniture

WHEN H. L. McDaniel, a fireman of Fort Worth, Tex., saw countless pieces of furniture demolished by the high-pressure water jets that were turned on burning houses, he set about devising some way of taming the fire hose for use at close range. Now the fire nozzle he invented is in use by the local department. By a quick turn of the wrist, the nozzle is made to spray two less forceful streams of water from outlets on its side, which can be used inside a small room without damage. The usual powerful single jet is available for use in an instant whenever it is needed.

The fire hose nozzle invented by H. L. McDaniel, of Fort Worth, Tex., to convert one powerful stream that would wreck furniture in a home into two less powerful ones that will deliver as much water, but more gently. A turn of the nozzle changes it from one form to the other

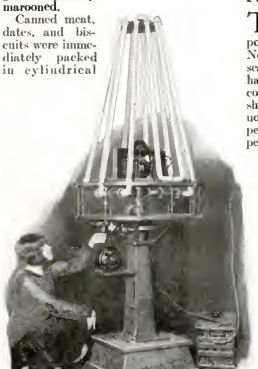
Plane Drops Food to Caravan Bogged in Desert

Another exploit that will find a place in aviation history is illustrated here by the artist from reports of an airplane's life-saving service to a caravan of men, women and children bogged and hungry on the Irak Desert. An air mail flyer, seeing the voyagers' plight, reported it. A plane was sent to drop food packed in metal containers to the mud-bound travelers

HOW an airplane rushed food to a motor caravan bogged in the mud of the Irak Desert is strikingly illustrated in the sketch above, drawn from reports of the recent incident.

Heavy rains had made the Mesopotamian waste impassable, and a passing air mail plane observed the motor transport that crosses it stranded in the mud fifty miles west of Ramadi, with its men, women and children passengers hopelessly marooned.

Canned meat, dates, and biscuits were immediately packed in cylindrical metal containers, fitted with buffer caps, and dispatched by airplane to the hungry travelers. As the swooping plane passed overhead, far above the treacherous mud that had engulfed the land vehicles, it released the cylinders with parachutes attached. Eagerly they were seized and retrieved, while Arabs of the party evidenced awe at the seeming miracle of "manna" dropping from the skies.



When the platform holding these bars of "neon" light revolves the effect is of a red cone—a beacon that aviators are said to be able to see 120 miles in fog

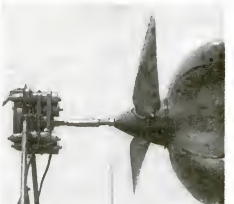
Novel Beacon Challenges Fog

THE latest fog-piercing beacon for airplanes is the 1,300,000-candle-power light, recently demonstrated in New York City, whose flaring cone of scarlet is said to be visible through thick haze for 100 to 120 miles. It whirls constantly on a revolving platform as shown at the left, to give a more conspicuous display. The remarkable cloud-penetrating ability results from its peculiar red-hued "neon" light, similar to that of another aviation device described in POPULAR SCIENCE MONTHLY last June. For more than a year, says the maker, the new beacon could be run day and night without requiring any adjustment.

Queer Early Auto Ideas

WHAT the automobile might have been is disclosed by U. S. Patent Office records. A Kalamazoo, Mich., man's self-starter was a hinged chassis that dropped the body a foot or two, operating cogs that cranked the motor. Another invention was a windmill-like blower to banish road dust.

Other devices were a box to sprinkle sand beneath the wheels in wet weather and a phonograph to announce a turn or a stop.



New Airplane Self-Starter

FOUR electric motors in a new self-starter for planes whirl the propeller to set the engine in operation. The device was first used by Lieut. Alford J. Williams for his plane, which recently made a new unofficial world speed record.

Storage batteries supply current to spin the shaft; when the plane's engine starts, the device automatically unmeshes and slides clear.

Photographic Film of Wood

FILM coating made from wood-fiber cellulose, instead of gelatine, may revolutionize photographic methods. It is said to permit ten-minute development, including drying of the wet negative.

Plane's Sideways Drift Found by New Device

TO DETECT and record the sideways drift of an airplane during flight, a factor that has often upset the most carefully planned voyages of skillful aviators, a new instrument has just been perfected by Rubino Plastino, war-time inventor of military devices. By an automatic photographic device, it is said to produce a complete record of the plane's travels through space. The new apparatus is about to be placed on the market.

Broadcasting Station Is Pride of Students

THAT they conduct their own broadcasting station is the proud boast of the radio class members at Lane Technical High School, Chicago. Great interest has been shown by the students in this project, which enables more thorough teaching of the principles of radio than could otherwise be provided. Harry C. Rowe, Jr., national champion radio builder for 1926, is one member of the class.

Among the class members many original experiments are made, and any one of these students may discover new facts of the utmost importance in the still youthful art of wireless.

Harry C. Rowe, Jr., champion radio builder (standing) explaining mechanism to William Hawley, comrade in Lane Technical High School, Chicago. Above: Rowe and William Loebel, Jr.

Dies Setting Altitude Mark

CAPTAIN HAWTHORNE C. GRAY again reached a height of 42,470 feet, the greatest altitude any man has ever attained, in the recent balloon ascension that cost him his life, the War Department announced after calibration of his barograph by the U. S. Bureau of Standards. His previous record-breaking flight to the same altitude was described in the September POPULAR SCIENCE MONTHLY.

The first mark, official in this country, was not internationally accepted because the flight ended in a forced parachute drop. This time Capt. Gray hoped to set a new record and take elaborate observations of the upper atmosphere.

Anxiety that followed his failure to reappear after he had vanished in the clouds above Scott Field, Ill., culminated next morning in the discovery of his balloon in a tree near Sparta, Tenn. Its basket contained the body of Capt. Gray, his hand still clutching a log book. The last entry showed he was at 40,000 feet and had just dropped his last ballast. Death came, it is believed, when in the thin air Capt. Gray became too weak to open the valve of his second oxygen tank. Three full oxygen tanks remained in the basket.

When Stamps Stick Too Soon

WHAT makes postage stamps sold in book form often stick to the separating leaves has just been investigated by the U. S. Bureau of Standards. As a result of its tests, it has advised the Bureau of Printing and Engraving, where the stamps are made, that it may find a special moisture-proof cellophane, thin transparent material often used in wrapping of candy, better than paraffin sheets to separate the stamps in books.

A Method for Secret Radio

MEANINGLESS jumbles of syllables were formed into intelligible words by a unique radio device recently demonstrated at Chicago. When Sergius P. Grace, of the Bell Telephone Laboratories, spoke a curious sort of gibberish into a transmitter, a loud-speaker formed the words, "Chicago, Illinois."

The odd device is intended to facilitate secret radio communication. Ordinary words will be converted into the code language at the transmitting end, by converting low tones into high ones and high into low, producing the gibberish of which Grace demonstrated the principle. At the receiving end, other apparatus would automatically de-code the secret language and re-form it into English syllables.

Swiss Mountain Toppling; Farmers Evacuate Valley

AT ANY moment now Monte Arbino is likely to topple into the Arbedo Valley, in Switzerland, and local authorities have been advised by the Swiss Geological Survey to remove the farming people of the valley to another part of the country with all possible speed.

For years it has been known that the mountain was sliding. Its summit at first was moving about one inch a year. Of late this has increased to fourteen inches. This year heavy rains and numerous earthquake shocks are expected to precipitate a catastrophe; it is believed no human power can prevent the whole mountain from crashing and burying the farms beneath tons of debris.

Storage Battery Locomotive

SECRET tests of a new and revolutionary type of storage battery, of unusual capacity, are being made in London, say recent reports. It is said to be powerful enough to drive an express train for a long distance over standard track, requiring no third rail or overhead wires. It is also claimed that, if successful, the battery could also be used for the propulsion of automobiles.

A Tip-Table Cone Speaker

RADIO music from the table is the innovation offered in an attractive furniture piece recently placed on the market. Its design suggests many unique possibilities both decorative and useful, for it may well be used as an aquarium stand or for flowers, while on the other hand a game of bridge on its musical top would be quite delightful.

The speaking unit is so constructed that the entire wooden casing is used for a sounding board and the table top may be tipped, if desired, to various angles without changing the tone quality. When the top is in a vertical position the piece occupies little space and may be set out of the way in a corner of the room.

A flat loudspeaker on a swivel forms the top of a novel tip-table which serves many needs while giving music

Man Can Lose Many Parts of Body and Carry On

IT MIGHT be inconvenient to lose an arm or a leg—but you could, if you had to, go usefully about your work without these, and an eye and a set of tonsils as well. For that matter, asserts Dr. John F. Erdmann of New York, you'd get along pretty well without an appendix, gall bladder, one kidney, part of your lungs, a portion of your brain, and as much as twelve feet of intestines in addition.

Better methods of surgery and increased knowledge of the functions of organs, Dr. Erdmann recently told the Interstate Post-Graduate Medical Association, are increasing the number of organs a human being can safely lose to the surgeon's knife. Recent advances are operations on the heart and removal of lobes of the lung and of the gall bladder.

Junk Made into Snowplow

DISTASTE for the snow shovel led Arthur E. Beauchamp, of Hartford, Conn., to assemble an ingenious motor-driven snow sweeper from varied items in the junk heap. A wheezy but efficient two-cylinder motor runs the machine. It draws gasoline through a rusty carburetor from a tank the size of a thermos bottle. Through a bicycle sprocket and chain the motor drives a spinning brush that once belonged to the city street cleaning department. The whole is mounted on a baby carriage chassis, supported at the rear by two lawnmower wheels. "But it certainly takes off the snow," Beauchamp remarks as he saunters behind the machine while neighbors cease shoveling to rest their weary backs and watch.

Mounted on a baby carriage chassis and old lawnmower wheels, this sidewalk snowplow is driven by sprocket, chain and an old two-cylinder motor

Plane Model Flies Almost 6 Minutes

BY STAYING in the air for five minutes and thirty-seven seconds, a model airplane built by John Lefker, 12-year-old schoolboy of Chicago, recently established a new world's junior duration record for outdoor model flight. The mark was made at the National Miniature Aircraft Tournament at Memphis, Tenn.

John Loughner, of Detroit, international model champion, holds the world's record for all classes. One of his machines kept the air at Philadelphia for ten minutes.

Coal Gasoline Wins Races

WITH synthetic gasoline, German motor cars won two of the recent races at Frankfurt. The cars, averaging nearly a mile a minute, made better time than in trials with ordinary gasoline.

The new fuel is made by a chemical process from coal. Since crude oil, source of standard gasoline, is scarce in Germany and coal plentiful, the new product is economical. In America its manufacture might not pay at the present time.

Tiniest Real Train Uses 15-Inch Track

THIS is not a scene in an amusement park, but a picture of a passenger train of the Hythe and New Romney Railway line passing through Hythe on the southern coast of England. Said to be the world's smallest public railroad, it operates over a fifteen-inch gage track of eight miles and claims the amazing record of 178,000 passengers in ten weeks.

The train weighs but eight tons, and exemplifies the last word in locomotive engineering in its representation of the equipment used on larger systems.

Sea Plants Make Sugar

TONS of sugar, which fishes immediately gobble, is produced by microscopic ocean plants called diatoms, says Prof. H. H. Gran of the Norwegian Fisheries Bureau, who has just completed measurements of their activities. They absorb energy from sunlight, and use it to make sugar from air and water.

Sharp-Turning Car Wheels

SHARP curves have no terrors for a motor car equipped with this new revolving axle. A small lever on the front axle tips the wheels almost completely sideways when a turn is to be made. Flattened out, the front wheels swing the car around more sharply than would otherwise be possible. Pleasure cars and trucks can be equipped with the new device, to aid in parking and driving.

"Foolproof" Plane Tested

IN A specially-built, "foolproof" plane with enlarged control surfaces, Clarence Chamberlin, transocean pilot, recently gave an amazing demonstration of safe flying at the Teterboro, N. J., airport. His first stunt was entirely involuntary. When his engine stalled, unexpectedly, while the plane was at an altitude of only 1000 feet, Chamberlin glided two miles without power to the landing field. Later he showed that the plane could land at a speed of fifteen miles an hour, on an even keel, without the pilot's hand on the control stick! After grounding smoothly of its own accord, the lightweight craft—it weighs but 500 pounds—rolled only seventy-five feet to a stop. It took off again after a brief run of sixty feet. Despite its risk-eliminating features, it is said to be a speedy machine.

The new control surfaces are said to avert the danger of a dive or spin.

Probing into Volcano's Past

FIXING the date of a volcanic eruption by a study of magnetism is the feat just accomplished by A. E. Jones, of the Lassen Volcano Observatory. Since records have been kept, Lassen Peak, in northern California, has never been seen to erupt; but two flows of solidified lava near its top have interested geologists.

Not long ago, Dr. P. L. Mercanton, French physicist, discovered that lava flows, at the time of their solidification, acquire magnetism from that of the earth.

The earth's magnetism varies in direction from year to year, with a shifting of its magnetic poles; and records of this change have been kept for centuries. By comparing the direction of the lava's magnetization with the records of the earth's, Jones dates one lava flow in 1832 and the other in 1795.

Distinctive People In Odd Activities

A Blind Inventor—Vicar Expert Silversmith—Butcher a Sculptor In Lara—Senator a Tree Doctor

The In-and-Out Bus

A bus to avoid inconvenience and loss of time has been designed by C. H. Ballard, a motor driver, of London, England. Passengers leave from exits at one end, while others go in by entrances at the other. Exits of both the top and the main "deck" of the vehicle are controlled from the driver's seat

Novel Dirigible Propelled by Air

Wellington B. Wheeler, of Los Angeles, exhibits a model for his proposed "flying fish" dirigible, which he believes will revolutionize flying. The force of air entering through the craft's nose and expelled by blowers through the finlike appendages on the sides will propel the craft, he says. An automatic stabilizer is another novel feature

Senator Tree Doctor

When Smith W. Brookhart, U. S. Senator from Iowa, finds time to spare from other duties, he spends it at tree surgery at his new home at Hyattsville, Md., not far from Washington. In the photograph at the left the Senator is seen in overalls operating on a tree in his yard

Blind Man Is an Inventor

Although he has been totally blind for more than fifty years, George Keith, of Illinois, pictured at the left, has invented an array of articles that range from combination locks with more than 25,000 combinations to traps for almost all known animals. A number of his patented devices have proved successful. Keith, who is a machinist by trade, is seventy-two years old, but says he is not near through inventing. He is shown at left at work on one of his animal traps

Sea Life Is Modeled in Glass

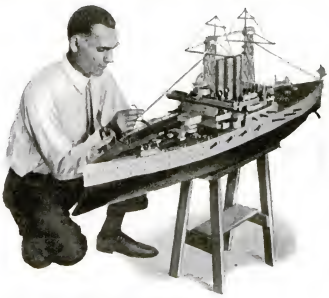
All the skill of the expert glassworker is combined with the knowledge of the naturalist in the unique models of forms of marine life prepared by Herman Miller, glassworker of the American Museum of Natural History. Completed, they will form a perfect exhibit of undersea life. The glass objects, many of them of amazing delicacy, are far more permanent than the actual specimens from which their designs are so accurately copied. It is for the sake of this permanency that the models are made

English Vicar Is Expert Silversmith

In his London study the Rev. C. G. Langdon makes hand beaten gold- and silverwork of rare beauty, also setting stones in rings that he makes in his leisure hours

Oregon Butcher Models Beautiful Statues of Tallow and Lard

Wilbur Freece, of Portland, Ore., has won fame as a sculptor, although he is a butcher by vocation. Using lard and blocks of tallow, he molds and cuts beautiful and lifelike figures, some of which won him first prize at the International Live Stock Show at Portland. The photograph above shows the butcher-sculptor producing one of his best masterpieces



Warship Whittled from Wood

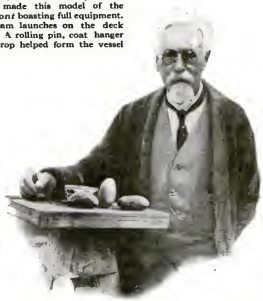
With spare time, a penknife and $13 worth of wood, Charles A. Cary, of St. Louis, Mo., made this model of the U. S. S. *Vermont* boasting full equipment. Even the steam launches on the deck have boilers. A rolling pin, coat hanger and razor strop helped form the vessel

Woman Wields Sledge on Rock Drill

Mrs. Mattie Cook, Spruce Pine, N. C., in a recent contest set a record by driving a steel drill twelve inches into solid granite in twenty minutes

Ocean Plane Model for 50 Passengers

Alexander Kartrely, left, and Edmund Chagniard show the model of the plane they hope to build for trans-Atlantic service. The giant craft, propelled by seven engines, would weigh forty tons



He's Trying to Tame a Wild Fruit

G. P. Rixford, of the U. S. Department of Agriculture, is experimenting on his Los Altos, Calif., ranch with the wild pawpaw tree fruit, which he hopes to domesticate. It looks like a potato, but has a sweetish pulp similar to that of a banana

Courtesy of Maurice E. Connolly

Is wood durable? The middle part of this house at Elmhurst, Queens Borough, New York City, still in use, was built by Samuel Moore in 1660. After 268 years there is no evidence of decay in a plank or beam of this quaint old structure, built when Uncle Sam was yet unborn

How to Select Your Lumber

Why You Can Build a Better House if You Use Care In Choosing Just The Right Wood for Each Purpose

By JOHN R. McMAHON

"ALICE and I came to buy the wood to build our new house," stated the young man at the lumber yard office.

"Yes, Mr. Morton, and we're in a terrible hurry, because we have to catch a train in forty minutes," said blue-eyed Alice with an appealing smile. "So I know you'll wait on us right away."

"Sure thing," chuckled the rubicund and grizzled lumber merchant. "I'll have it wrapped up in a jiffy. Just say what you want."

"George has the plans. Give them to Mr. Morton, George," directed the efficient young woman. "You see it's a Colonial house, all wood."

"I see. A nice six-room cottage. Now have you young folks ever looked into the question of kinds and grades of lumber?"

"Don't believe we have," confessed the boyish husband.

"Well, I admire your spirit. Most people leave all these details to a contractor or carpenter. You want to buy the raw materials yourselves and have them put together by day labor, I guess. But it wouldn't hurt those who have a contractor to study the question of materials. There are questions the owner can best decide himself after the facts are put before him. Now suppose you newlyweds call at my home some evening this week. We'll spend an hour or so discussing lumber and then when you come here to shop you'll know what's what and get a real bargain."

"WILL you bring some samples?" inquired the young woman.

"Oh, I guess so," laughed the merchant. "Everything except sills and girders that are too hefty for a man of my years to tote around."

On the appointed evening, Mr. Morton began by explaining lumber's numerous qualities or grades, ignorance of which causes many troubles of amateur buyers.

What Is Your Problem?

Many hundreds of problems are sent to this magazine's Home Building Department or to Mr. McMahon, who conducts it, and all are gladly answered for readers. Many of the letters come from almost the ends of the earth. If you wish advice in planning your home or to assist friends or relatives, you are welcome to write to Mr. McMahon, care of this magazine, or to Home Building Department, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

"A cheap bid on a house probably means low quality lumber will be used," he said. "You don't expect a cheap pair of shoes to equal a pair made of good leather. Of course, fancy quality may run into looks, and instead you may be satisfied with a sound medium grade."

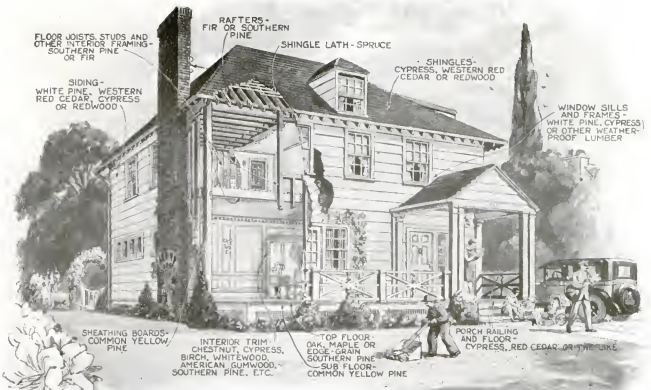
"What are the grades called?" asked George.

"American Standard is the general name for softwood lumber, which comprises the principal material in a frame house. Under this standard there are four grades of 'Select' material used for trim and finish. These run from Grade A, which is perfect, down to D, the poorest.

In some kinds of wood A is left out or included in 'B and Better.' Two minor defects, as small knots and pitch pockets, are allowed for each eight surface feet on the face side in Grade B. I would hardly advise you to go lower. C allows twice as many defects. Knots and pitch are undesirable on exposed fine work, since they tend to show through shellac and paint after a time."

"I GUESS ordinary boards are in a different class," said George.

"Yes, they qualify as common lumber, known as No. 1 Common



This picture diagram shows the construction of a house and the various kinds of wood that should be used in it according to the purposes they are to serve

down to No. 5 Common. The first and best may have defects that do not affect its strength; it is supposed to be watertight. The next grade, No. 2 Common, has more faults, and I would not go lower, whether for a subfloor or sheathing walls or roof. However, some people use No. 3 for covered work after cutting out the worst parts.

"When we come to so-called dimension or framing lumber, which includes two by fours, joists, rafters and so on, we find three grades, which resemble the first three in the board list but also embody the factors of stiffness and strength. The middle grade is generally satisfactory. Structural timber may be also graded in detail as Select or Common, while Dense Select is a top notch specimen of Douglas fir or Southern pine. The grading rules ignore color, amount of heartwood and method of sawing, but the customer may obtain selection on these lines. Color is a matter of looks, heartwood means the most durability, sawing in flat grain is good enough for common lumber but edge grain or quarter sawed is superior for top floors, trim and shingles. Grading of hardwood has not yet been fully standardized but is on its way."

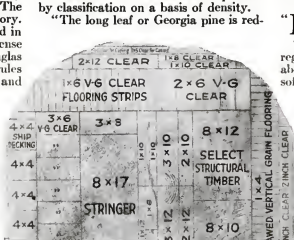
"HOW many kinds of wood are there, Mr. Morton?" asked Alice.

"About thirty that are largely used in home building. Several of these are bunched under single titles, which is a good thing. We have too many duplicate names for the same variety, which confuses people. America grows over a thousand different trees, which have no less than ten thousand names. There ought to be a law to reduce this verbiage. Fortunately, a home builder does not have to worry about more than a dozen or fifteen names."

"What is Southern pine?" asked George.

"That is a general name for half a dozen species of pine growing in the South—long leaf, short leaf, loblolly, slash and others. The lumber is medium hard. It is widely used in framing, sheathing, even in top flooring and inside trim. There is a considerable difference in quality according to species, although it is claimed the differences are equalized by classification on a basis of density.

"The long leaf or Georgia pine is reddish and yields lumber both long and sizable with the fewest knots. When quarter sawed it makes good top flooring at less cost for labor and material than hardwood. Labor is saved because the pieces are long, which saves fitting. The ends are now tongue-and-grooved as in oak. Short leaf or North Carolina pine is satisfactory as top flooring if quarter sawed and selected. Flat grain becomes splintery and uneven under wear. There are enough legitimate uses for Southern pine without asserting, as some do, that it is suitable for all parts of a dwelling."



Transverse section of Douglas fir log as it might be sawed. The diameter at 30 years was 14 inches; at about 300 years, when cut, it was 42 inches

"I HAVE heard that white pine is either coming or going—which is it?"

"Going, I fear," replied Mr. Morton regretfully. "I have a sentimental feeling about that noble timber that is white and soft as a child's hand, yet endures like granite. A white pine house in Massachusetts was the home of my ancestors for two and a half centuries. The original New England supply is about exhausted, but we may still obtain it from our Northwestern states, eastern Canada and the Pacific coast, where it is termed California sugar pine. White pine is good for all parts of your house exposed to the weather, and excellent for choice interior details. It does not warp, crack or splinter, has an ideal workability, and takes a fine finish. It is the thing for home cabinetwork, shelves, bookcases and all repairs."

"I'll remind George of that later," said Alice. "Are there any more passing trees that you mourn?"

"Hemlock is on the list, but it never engaged my affections," chuckled the rubicund dealer. (*Continued on page 126*)

New Tools That Simplify

Quick action and nonsplashing, this new mop wringer is an added convenience for any household. Metal tabs over the holes deflect the spray downward when the mop is wrung by an easy pressure on the powerful lever. The wringer is designed to hang on the rim of any pail and is so fashioned that it can be readily attached regardless of the size of the rim. It is of sturdy, durable construction

An end to the fraying of electric wires that run your toaster or vacuum cleaner is claimed in an ingenious hook for the attachment plug that makes it as easy to pull the plug with your fingers as by jerking on the wire. No rewiring is needed; the finger grip is slipped over the plug and then tightened with a screw driver

Comfortable and resilient, a new kneeling mat is made of sponge rubber. It provides a soft cushion for the housewife who is faced with the tiring work of washing or polishing floors. At the front of the mat a rubber ledge, slightly higher than the base, keeps moisture and dust from the worker's knees

Of odd design is a new slicing knife for kitchen use. Two deep and many small "nicks" in its blade, say the makers, adapt it to cut oranges, lemons, grapefruits and pineapples, as well as tomatoes and other vegetables, with added smoothness and ease. It is made of a high grade of steel

The odd-shaped new refrigerating device seen at the left terminates in two spheres. Once a day you heat one sphere on your stove; then, placed in the ice box with this end protruding, it keeps it cool all day. A volatile, liquefied gas is compressed within the balls. When the outside ball is heated, the liquid is gasified and forced into the refrigerator ball, which has been placed in cold water; here it condenses into liquid again It is this ball which chills the box

A new type of teakettle recently exhibited at an invention exposition in Westminster, England, has a top that can be lifted off, making it simple and easy to give it the cleaning the ordinary utensil seldom gets. Similar to an ordinary saucepan in its design, the new article is said to boil more quickly than the old kind

From France, famed for its salads, comes this new invention to dry lettuce speedily after washing, preparatory to salad making. When the wet lettuce is placed in the wire cage, a few turns of the crank whirl it and speedily eliminate the moisture—in much the same manner a "centrifugal dryer" dries clothes

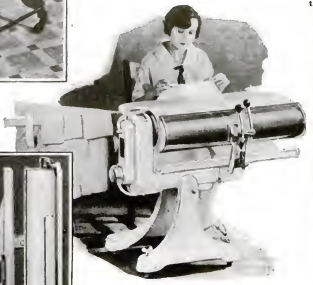
For cooking cereals, or vegetables, the new double boiler of porcelain illustrated below is said to be particularly suitable. Its smooth, shining white walls lend themselves readily to the cleaning brush or rag, and are easily kept spotless. When in use, the porcelain container keeps contents hot when removed from the kettle for several minutes

Tasks of the Home

Making ice cream, grinding meat for sausages, or cleaning your knives is equally easy for a versatile new electric machine. Attachments include buffers for polishing silverware and an arrangement whereby the device may be hitched to a meat grinder or to an ice cream freezer

Like a miniature rolling pin is a new kitchen implement that rolls out noodles "by the yard." It is made of metal, and its length is serrated with circular knives that cut many strips at once. Three rollers are provided, for narrow, medium, and wide noodles

To cook a number of dishes at once an ingenious new water bath has been devised to fit over two burners of the gas stove. When it is filled with water, a constant even heat is maintained in each of the several food compartments. It is useful, too, to keep other foods hot and ready to serve



Compact enough for the smallest apartment kitchen is the new electric ironer that folds up, seen at the right. It has all the latest conveniences for flat work, shirts, dresses, and everything that a hand iron can do—but with added speed

The photograph above shows the new electric ironer in use, while that at the left pictures it folded up to be set in a closet or out-of-the-way corner. The machine uses no foot or knee control. A touch of the fingers suffices to operate all attachments

On the inside of a closet door fastens a handy new umbrella rack. It keeps the umbrellas in order, and prevents them from getting torn or lost. At the top a spring clip holds each one; water drips into a moisture-tight pan below. Only a screw driver is needed to install it

When you want to warm a little water, use this handy new apparatus. Though it does not boil the water, the little metal cylinder inserted in the liquid quickly brings it to the desired temperature. A charge of a special powder that comes with the device is inserted in the cylinder

How long will a hot water bottle stay hot? An ingenious new electric heater that screws into the mouth is said to maintain heat for any desired time. Simply fill the bag with warm water, screw in the plug and attach the wire to a light socket. The device is intended simply to keep the water from cooling

Coffee cups, too, are now made of transparent oven glass, so they can be filled with no danger of breaking, and the connoisseur can judge the color of the brew and detect the presence of grounds. They enable the rich color of the drink to add to its delight. Saucers are made to match

Fine Points for the Radio Fan

"Fool-Proofing" Your Set

Tools to Simplify Hard Work—How Long to Charge a Battery

WHILE some radio fans take pride in the fact that they can turn out good work with only a few tools, such as a bent screw driver, a battered pair of pliers, and a soldering iron that works only part of the time, most radio fans don't like to work that way.

You will find that any job, no matter how trifling, can be done easier, better and faster if you have the right tool for the job. That does not mean, however, that you must buy out the contents of a large hardware store so as to be able to tackle any job with exactly the right tool.

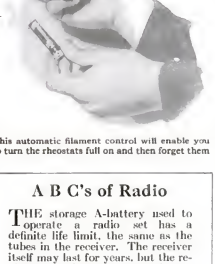
One of the illustrations on this page shows two tools that are not expensive and yet serve greatly to facilitate all ordinary radio wiring jobs. One is a pair of diagonal cutting pliers. This is particularly useful in soldering wires between terminals that are very close to each other. Instead of cutting off a very short piece of wire that will just reach from one terminal to the other, use a long piece as shown in the illustration. You can hold the piece so that the bent end touches the two terminals, solder it at both points, and then, with the pliers, cut off the superfluous wire close to the terminal.

This method avoids the trouble you usually have with a connection where the heat necessary to solder the second connection loosens up the first one.

The other tool shown in the same illustration is a pair of what are known as duck-nosed pliers. This tool takes the place of clumsy thumbs and oversize fingers in holding work in odd, hard-to-get-at corners. After you have owned a pair of these pliers for a while you will wonder how you ever got along without them.

Aside from holding the end of a wire while you solder it in place, these pliers will prove useful in holding nuts in close quarters while you turn the screw with a screw driver in the other hand.

Then you really ought to have two or three screw drivers of the long, slender variety. Many screws in radio apparatus are tucked away in corners that you can't get at with the ordinary short, stubby screw driver. You will find it worthwhile to keep your screw drivers in good condition. When the edge of the blades get dull so that they slip out of the slot in the screw on the slightest provocation, get out your carborundum stone and sharpen them to clean, square corners that will stick to the slot of a screw head as long as there is any slot to get a grip on. Screws that you can't remove at all with a dull screw driver are easily persuaded to loosen up when a real blade is applied to them. Hence a little time in caring for your screw drivers will save much time in using them.



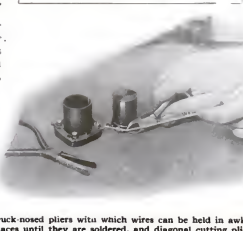
This automatic filament control will enable you to turn the rheostats full on and then forget them

A B C's of Radio

THE storage A-battery used to operate a radio set has a definite life limit, the same as the tubes in the receiver. The receiver itself may last for years, but the replacement of the vacuum tubes at intervals averaging about a year and the storage A-battery at long intervals is a legitimate part of the upkeep expense.

The life of a storage battery depends on the care it receives. It may give out in six months or a year if neglected, or it may last as long as five years if it receives the right care.

The worst thing you can do to a storage battery is let it run down and stay in that condition for more than a few hours. More storage batteries are ruined through this one cause than all others combined. Long continued charging at excessively high rates is bad for a battery, but not nearly so harmful as letting the battery stand discharged. Most radio batteries do not receive enough charging to keep them in really good condition.



Duck-nosed pliers with which wires can be held in awkward places until they are soldered, and diagonal cutting pliers to cut off superfluous wire after short connections are made

Automatic Filament Control

IF YOU are tired of having the family turn the rheostats on your battery-operated radio set on so far that the tubes become paralyzed, you can make the set "fool-proof" by applying an automatic control device such as is shown in the illustration at the top of this page.

All you need do is cut either of the wires leading from the A-battery and clip the bared ends in the special clips at each end of this device. Then you snap in place a pair of automatic controls that will pass the right amount of current for the number and type of tubes in your set. Turn the rheostats on the set all the way on and forget them.

Which Power Tube?

WHILE the designation "power tube" as applied to the special tubes used for last stage amplification is technically correct, it has led to a serious misunderstanding.

A power tube is one that will handle a lot of power as compared with the standard 201A type tube but power, in the sense that it is used here, means ability to handle more volume without distortion. It does not mean that the tube amplifies weak signals and makes them sound louder than they would if a standard 201A tube were used.

The problem is, therefore, under what conditions does a power tube improve results? Four types of power tubes are available and each has its particular advantages, but no power tube is really worth while if you are located so far from the nearest broadcasting station that you never get the signals at above a rather weak volume level. If you are situated where the majority of stations are received weakly, use the 112 type power tube. Its amplification factor is about the same as the 201A; it gives the same volume on weak signals. If you are living where a number of stations are received with plenty of volume, use the 171 type tube. It doesn't amplify as much as the 112 but you can turn the volume control quite a bit farther with this tube than you can with the 112.

The 210 tube combines the advantages of both 171 and 112. It amplifies weak signals as well as the 112 and on strong signals you can turn up the volume control till the music or speech is twice as strong as it is with the 171.

Radio Noises You Can Cure

You Can't Get Rid of Static, but You Can Tame Racket from Household Electric Devices and Loose Contacts in Set

By JOHN CARR

Soldering a ¼-mfd. condenser across the contact points of a buzzer charger stops interference

WHEN crackling and sizzling interfere with your radio reception, you may decide that something is wrong with your receiver and put the problem up to the local radio service man.

Or you may blame it on static or on the electric light power transformer in front of your house.

But if your diagnosis is one of these causes, what are the chances that it is correct and that you can get rid of the interference?

Recent investigations by power companies have brought out some remarkable facts about radio troubles and their cure. For instance, more than a third of the troubles investigated turned out to be false alarms. The sets were working as they should. The owners were bothered with static but couldn't recognize the trouble. And according to the best authority there is nothing you can do about static.

Investigations have shown that defects in pole transformers capable of disturbing near-by radio fans are extremely rare.

There are two noise producers you can get rid of.

ONE is trouble within the radio receiver itself; the chances are about one in four that your set is to blame. This does not include whistling or other sounds of a sustained character. It applies only to those irregular, rough, grating, frying noises that sound just like static.

These noises arising within the set itself are almost without exception due to a loose contact. It makes no difference whether you have just gone over the connections. If you hear irregular scratching and grating noises when you have disconnected both the antenna and the ground wires, you can bet that if you look long enough you will find the loose connection. There is just one case where this does not apply. You may still hear a noise with both the antenna and ground off if the disturbance is created by a piece of electrical machinery located close to your set, but even in this case the strength of the noise will be diminished when you take off the antenna and ground.

Many kinds of electrical machinery may cause trouble, but machinery producing no sparks does not. That's why the pole transformer, except in rare cases, is innocent.

The tiniest little spark inside the thermostat of a heating pad or the minute sparks from the brushes of a five-dollar electric fan may create a noise from your loudspeaker resembling a load of coal going down a chute.

The New Electric Set!

You will find the first of a series of articles on how to build a new and tremendously powerful full-electric radio receiver on page 78 in the Home Workshop Department of this issue.

What counts is the location of the spark with reference to wiring that may act as an antenna to transmit the spark to your set. The more easily the spark can act on lengths of wire hung in the air the greater the disturbance. That is why a street lamp, when it becomes defective and starts arcing at the contacts, will cause trouble in every radio receiving set located within a large radius.

Any poor contact in the electric wiring of your house is a serious matter. It means a succession of minute sparks that cause radio interference, and if neglected long enough may set the house on fire.

After you are sure your receiver is not to blame for the noise, the next step is to find out if it is due to either a loose connection in your electric wiring or to some piece of apparatus operating from it. If your set is battery-operated, all you need do is screw out the main fuses near your electric meter while the disturbance is going on. If that stops the trouble it's a sure thing that the difficulty isn't your own home. If it doesn't, it's equally sure that the source of electric sparks is outside your home and you can ask the power company if it has any suggestions. The companies are eager to aid. They know that radio interference cuts down the use of the radio and consequently cuts down the amount of current you use.

It is quite obvious, of course, that you can't make this test if you use a B-eliminator, because the set would cease to function the moment you screwed out the fuses. In such a case you might borrow a set of B-batteries.

AMONG the types of electric apparatus that may cause trouble are buzzer-type battery chargers, violet-ray machines, fans, vacuum cleaners, ice boxes, oil burners, washing machines, heating appliances such as electric flat irons, heating pads, electric grills and so on; and any other household electric appliance.

Some of these just naturally create disturbance whenever they are used. Buzzer-type battery chargers and the violet-ray medical outfits are in this class. Both instruments produce a copious flow of sparks from the vibrator with a steady roar of interference as a result. Other types of apparatus cause trouble only when they are defective. Heating appliances such as grills and toasters operate without creating disturbances unless one of the connections to the heating element is loose, in which case a noise is produced in the loudspeaker that strongly resembles the sound of frying eggs.

This same characteristic sizzling or frying noise is produced by any poor contact as distinguished from the crackling snaps of the sparks from a buzzer outfit.

Simple, home-wound radio-frequency choke coils often are needed in addition to fixed condensers to stop interference from electrical apparatus, such as motors, if the apparatus is in bad shape

The pole transformer outside your house may be causing the noises, but the chances are it is innocent. Don't blame the pole transformer until you are sure that there are no loose connections inside your set or that some household device is not causing the noise

The noise produced by the sparking brushes of a small motor is between these two, a sputtering sizzle that grinds on as long as the motor is in use.

The mere fact that you have tested your set and found it noiseless and have proved to your own satisfaction that nothing in your own house is causing interference is no guarantee the trouble is in the nearest electric light wiring.

It may be the sparks from the roller of an overhead electric trolley car, or perhaps the man in the house or apartment next to yours is running something that ruins your radio reception. Your neighbor may not have a radio set and so be unaware of the trouble he is causing.

Just as radio disturbances aside from static and heterodyne whistles can be summed up in one word, sparks, so the cure for these troubles ordinarily can be found in the proper use of one piece of apparatus, the bypass or filter condenser.

ELECTRIC sparks always produce high frequency oscillations that radiate and are picked up by your set. The function of the bypass condenser is to provide an easy path for these currents and thus keep them out of the wires from which they may radiate.

In theory, at least, all disturbing sparks can be rendered innocuous by means of bypass condensers, but in some cases the theory cannot be put into practice because of mechanical difficulties or because of the expense involved.

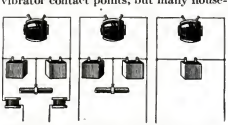
The sparks produced by the trolley wheels in overhead trolley systems is a case in point. If there were any practical way to split up the overhead wire into small sections, insert a radio-frequency choke coil between each section and then connect a bypass condenser between each section and the ground, the sparks would no longer cause trouble. But the expense would be prohibitive. While the condenser is the mainstay in killing radio interference from sparking apparatus, a radio-frequency choke coil is good in aggravated cases.

Although it has a high sounding name, the radio-frequency choke coil in the styles needed for interference prevention is the simplest of all coils. Just a few turns of wire wound criss-cross fashion on a wooden spool and you have it. See upper photo on page 69.

THE simplest connection for a bypass condenser is shown at the right in the diagram and as carried out in practice in the other illustration. In this case a vibrating or buzzer-type battery charger is being cured of its interference-causing propensities. Connect coudenser to the buzzer contacts.

The same method works with the violet-ray medical outfits, but you will have to take them apart to get at the vibrator contacts. If you don't want to do this you can get nearly as good results by connecting the eondenser across the lead wires from the electric plug to the instrument where they enter the case.

In every case it is desirable to connect the condenser directly to the wires that go to the brushes of the motor or to the vibrator contact points, but many household electrical devices are so constructed that you can't get at these connections. Also there are so many types and sizes of devices and motors that specific instructions cannot be given.



Three ways to cut out motor interference. The arrangement at the left is often sufficient. The one at the right is for severe cases. Make connections to brushes of the motor if possible

With many motors, using two condensers in series grounded at the midpoint will prove more effective in eliminating the interference. This is an especially good arrangement if the motor frame is not grounded.

At the left in the diagram is shown the arrangement to use in obstinate cases. Radio-frequency choke coils are added to force the interfering oscillations to flow through the condensers.

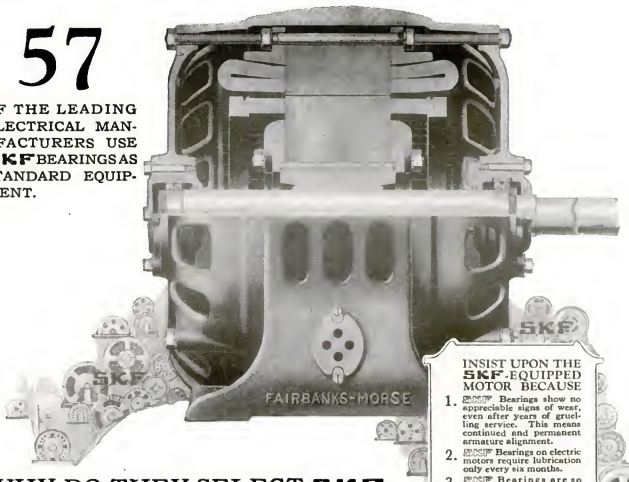
The size of the wire used in winding the radio-frequency choke coil depends on the amount of current drawn by the motor or other electrical apparatus. Two hundred turns of No. 14 double cotton covered wire wound jumble fashion on a wooden spool one and one-half to two inches in diameter will do in cases where the current is not more than five amperes.

AVOID winding the wire in smooth layers. The effectiveness of the coil as a radio-frequency choke depends to a large extent on winding the wire back and forth so that successive turns criss-cross each other as much as possible.

The capacity of the condensers needed to cut out the interference largely depends on the severity of the spark. The heavier the spark, the larger the condenser. One half microfarad condensers will do on small motors in good condition. Use one, two or four-microfarad condensers on big motors. You can start with small capacity and add to it by putting the additional condensers in parallel with those already in use. CAUTION: Use high-grade condensers with a rated working voltage at least twice that of the circuit in which they are to be used.

57

OF THE LEADING ELECTRICAL MANUFACTURERS USE **SKF** BEARINGS AS STANDARD EQUIPMENT.



INSIST UPON THE **SKF**-EQUIPPED MOTOR BECAUSE

1. **SKF** Bearings show no appreciable signs of wear, even after years of gruelling service. This means continued and permanent armature alignment.
2. **SKF** Bearings on electric motors require lubrication only every six months.
3. **SKF** Bearings are so housed that lubricant cannot penetrate and short-circuit the coil windings.
4. **SKF** Bearings are self-contained and require no adjustments.

WHY DO THEY SELECT **SKF**— *the Highest Priced Bearing in the World?*

YOU can't build a bearing on a basis of economy and expect it to *produce* economy in operation.

You can't put anything less than the best into a bearing and expect it to function at its best.

You can't expect a bearing to function properly in a motor if it never proved its ability to function properly in the laboratory and field.

And so, in spite of the fact that **SKF** Bearings are the highest priced bearings in the world, the leaders in the electrical industry, as in all industries, select **SKF** Bearings as standard equipment.

Nothing is apt to cost so much as a bearing that cost so little

It costs more to replace a poor bearing than to buy the best one that **SKF** *ever produced. And* **SKF** *Anti-Friction Bearings are the highest priced in the world.*

SKF

Ball Bearings Roller Bearings

SKF INDUSTRIES, INC. 40 E. 34th ST., NEW YORK CITY 1943

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Helpful Hints for Your Car

Windshield Sleet Wiper—Ending Cold Drafts—Other Useful Kinks

EVERY motorist quite frequently encounters the peculiar combination of atmospheric humidity and sudden temperature change that results in heavy fog forming on the inside of the windshield. The ordinary wiper, either mechanical or hand operated, wipes only the outside of the windshield and the driver continually has to wipe the fog from the inside of the glass in order to obtain clear vision.

Then there usually is trouble in winter with sleet freezing on the glass, in spite of the operation of the wiper. Fig. 1 shows how to eliminate both fog on the inside of the glass and freezing sleet on the outside. Remove the regular rubber wiper and substitute a tubular piece with a strip of felt let into a slot in its side as shown. A mixture of alcohol and glycerin

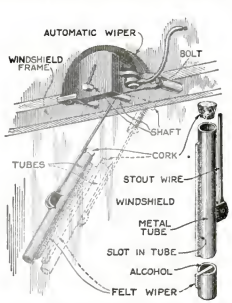


Fig. 1. Adjustment of a felt wiper to take sleet from outside or fog from inside of windshield

poured into the tube will allow the wiper to keep the glass clear in a sleet storm. A duplicate tube fitted to a special arm will take care of the inside of the glass in the most severe weather.

Ten Dollars for an Idea!

WALTER S. ESTBY, of Buhl, Minn., wins the $10 prize this month with his suggestion of a windshield wiper improvement (Fig. 1). Each month POPULAR SCIENCE MONTHLY awards $10, in addition to regular space rates, to the reader sending in the best suggestion for motorists. Other contributions published are paid for at the usual rates.

A Good Remedy For Cold Feet

WHILE it would be possible to fit the floor boards of an automobile so carefully that there would be no space around the pedals for air to blow through, most cars aren't made that well, and consequently there always is a blast of cold air coming up around the brake and clutch pedals in winter.

The result is cold feet and discomfort. The remedy is to fit a supporting plate covered with a piece of sponge rubber on each pedal at a point where it will press lightly against the underneath side of the floor board when the pedal is in the up position, as shown in Fig. 2. The idea is equally useful in summer to keep the heated air under the hood from burning your feet.

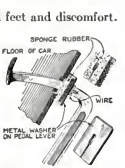


Fig. 2. A plate covered with sponge rubber, fitted on a pedal, keeps the cold air from chilling the feet

Putting a felt pad under the floor mat in both the front and rear compartments also helps to keep the car warm and also makes the car more silent, absorbing the rumbling and rattling noises.

For Use on Steep Hills

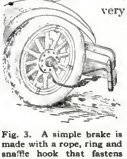


Fig. 3. A simple brake is made with a rope, ring and snaffle hook that fastens wheel and front bumper

WHEN you park your car on a very steep hill there is always the chance that some mischievous child will throw off the emergency brake and allow the car to coast down the grade into a serious accident. There are times, too, when you have to change a rear tire on a steep hill and you have to release the emergency brake in order to turn the wheel. On such occasions, you will find that a short piece of rope fitted with a ring on one end and a snaffle hook on the other will prove useful. As shown in Fig. 3, the rope is snapped in place around the rim of one wheel and the bumper. It will keep the car from coasting even if the brake is released.

Waterproof Glue for Tops

THERE are a number of waterproof cements on the market, but if you cannot secure any in your locality, a satisfactory waterproof glue can be made at home by taking an ordinary small bottle of glue and stirring in a teaspoonful of water to which has been added five or ten grains of potassium bichromate. The glue must be hot. After this mixture has dried and been exposed to the sun for a few hours, it will not dissolve or soften in water. It is fine for painting into small cracks in the top of a closed body and to repair a leak, and it looks much neater than a patch. On open car tops a neat repair can be made by using this waterproof glue to attach a patch to the inside of the fabric.

Wires Brace Garage Door

IF THE garage doors are sagging so that they no longer close properly, the best remedy is to have them taken down and repaired by a competent carpenter, but a temporary job can be done that will actually pull the doors back in place and prevent any further sag by drilling holes as shown in Fig. 4. Then a piece of stout galvanized wire is looped through the holes as indicated, and a bolt or spike used to twist the wire to take up the slack. Considerable tension can be obtained in this way—enough to pull the door into shape.

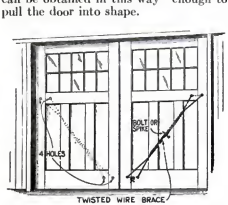


Fig. 4. Sagging garage doors are temporarily made right by drilling holes, running wire through them and then twisting it with an iron spike or heavy bar until the wire is as taut as possible

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Sam Loyd's Brain Bafflers

Put Your Wits in High Gear

Puzzles That Test Accuracy and Speed in Thinking

PUZZLES that are entertaining and valuable as well because they train the mind to think swiftly and accurately are offered here by Sam Loyd, the world's most famous puzzle maker. Try your capacities on these problems, noting the time you require to solve them: then look on page 153 for the correct answers and your ratings.

The Full Market Basket

"THERE, your basket's full," remarked the groceryman to Mrs. Miller; and with that casual comment for a text, the lady delivered quite a dissertation on the high cost of eatables.

"You fellows don't seem to realize that the war is over," said Mrs. Miller, among other things. "I can remember when it would have cost five dollars less to fill that basket. In those sensible days I would have got one third more food than there is in that basket for one third less money than has just passed from my pocketbook to your cash register."

That is as much of Mrs. Miller's argument as we shall need for puzzle purposes. If her statement is correct, how much did it cost her to fill her basket in the good old days?

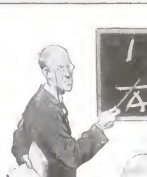
See how long it takes you to find out; then turn to page 153 and see if you have found the right answer in the time allowed for the problem's solution.

Building a Home

I AM planning to found a Puzzlers' Home, and in going over the estimates furnished me I find that they supply material that makes a very interesting puzzle. So whether the builders do the work or not, they have at least been of considerable value to people who love to try conclusions with difficult problems.

Here is the situation: The paper hanger and the painter will together paper and paint the building for $1100; the combined charge of the painter and the plumber will be $1700; the plumber and the electrician together will want $1100 for their work; the combined bills of the electrician and the carpenter will be $3300; the carpenter and the mason together will charge $5300; and the mason and the paper hanger together will charge $2500. Also, I see that the paper hanger's estimate is two thirds as much as the electrician's.

See how quickly you can determine the estimate of each man. The correct answer and the time given to find it are both given on page 153.



The Mysterious Letter A

SAYS the professor: "The letter A represents a certain number composed of five figures. When A is increased by placing the figure 1 before it and multiplying by 3, the product is A1." Who can translate the professor's A into a number fitting the conditions? See if you can; then turn to page 153 for the correct answer and the time in which it should be found.

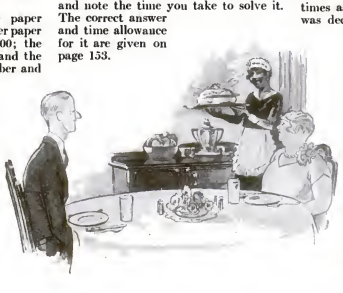
The Spratt Family's Pork

JACK SPRATT and his wife could together eat a barrel of fat pork in sixty days, whereas it would take him thirty weeks to perform this feat alone.

They could together consume a barrel of lean pork in eight weeks, although she alone could not dispose of it in less than forty weeks.

Under those conditions, how long would it take Mr. and Mrs. Spratt dining together to eat a barrel of mixed pork, half fat and half lean?

Try your capacities on this problem and note the time you take to solve it. The correct answer and time allowance for it are given on page 153.



Rails and Acres

A TEXAS ranchman who owns a vast extent of land boasted that in one square field that was inclosed by a three-rail fence there were just as many acres as it took rails to surround it.

Supposing the rails were just twelve feet long (no allowance being made for lapping) and the fence was three rails high, how many acres would there be if there were just as many acres as rails?

The answer and the time given for finding it are on page 153.

A Puzzling Post Card

TWO shut-ins whose mutual hobby is arithmetical puzzles keep up a lively contact through the medium of cipher post cards. One of their recent missives carried the following odd message:

"TNFGZ XQD IBZ UMBZZ UNPZT BNGMZB UMIF N MQH PDGM SQQBZB IP N UMIF XQD?"

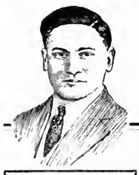
Since it is constructed on the simple principle of letter transposition—mixing up the letters of the alphabet—one should decipher that message without a great deal of difficulty. Perhaps the harder job will be to solve the arithmetical problem it sets forth.

Here we have really two puzzles in one. First your familiarity with letters is tested and then your facility in handling figures is put on trial. See how long it takes you to solve this pair of posers. Then look on page 153 to find the correct answers, and see if you have worked them out in the time allotted.

Taking in a Partner

IN THE old firm of Dombey & Son, the senior's interest was one and one fifth times as great as the junior's. Then it was decided to take Uncle Henry into the firm upon the payment of $33,000, which sum was to be divided between senior and junior in such a manner as to leave the interests of the three partners exactly alike. How should that $33,000 be divided between senior and junior?

It required considerable figuring to determine the proper division, and some persons would probably have given up the project rather than work out the problem. See if you can do it. After you have tried hard enough and succeeded or failed, turn to page 153, where you will find the correct answer and the time within which it should be determined.



I MUST empty my warehouse shelves, in preparation for a new series of better, larger, more beautiful books *at a higher price*. Little Blue Books will not be reprinted. Buy now, while the selection is complete. Orders will be filled as received and shipped at once.

E. Haldeman-Julius

I will pay the postage to clear out the last of the Little Blue Books at 5c each

[Postage Prepaid]

The people—millions of them—are actually demanding a great industrial change from Mass Production to Quality Production. They are showing this mood in the world of transportation—as proof I need merely call attention to the condition of the greatest automobile factories of the world.

In so many words the public has given me to understand just this—

"We do not want to save to the point of sacrificing individuality. We are willing to pay more for what we get—provided it meets the artistic standards of quality production, style, personality, distinction, beauty, and a degree of exclusiveness."

Recognizing cold facts, we decided to institute a vast publishing change. We shall close out our present stock of something like 3,000,000 Little Blue Books, and then we shall announce a new series of books—good books—**but not to sell at 5 cents per copy.** We shall bow to industrial evolution, and issue books at a higher price—books carefully selected for editorial content; books printed on very fine paper, bound in beautiful covers in many attractive colors. The type will be different. Expensive engravings will be used. The best artists will help us turn out a splendid article for the most discriminating readers.

How soon will we announce the new series? We cannot state this definitely, though it should be soon. We must first dispose of our stock of Little Blue Books.

The quicker they are distributed and turned into cash, the sooner will we be able to set our machines to work on our new publishing program.

If we dispose of these 3,000,000 Little Blue Books within the next 30 days—and that is not impossible—we shall be able to begin our new program at that time.

So we say this to the reading public of America—buy Little Blue Books now, while they are obtainable. Pick out your favorites while we have a complete stock to select from.

We can fill your order now, but we cannot guarantee how long our supply will last.

E. Haldeman-Julius.

Love

6 Love & Other Tales
24 Kiss & Other Tales
29 Dreams; Stories of Passion's Pawns
74 Physiology Sex Life
84 Love Letters of a Nun
87 What is Love?
89 Love Letters of Men & Women of Genius
98 How to Love
172 Evolution of Sex
175 Hindu Love Book
178 One of Cleopatra's Nights. Gautier
197 What Frenchwomen Learned of Love
199 French Prostitute's Sacrifice
203 Love Rights
222 Vampire & Other Poems. Kipling
250 Romeo & Juliet
317 A Night Flirtation
410 French Amorous Misadventures
540 Brightly Colored Tales of Passion
541 Passion Stories of Many Hues
665 Love Letters of a Parisian Actress
672 Illicit Love, etc.
673 Tales of Love & Life, Boccaccio
746 Daughter of Eve
817 Her Burning Secret
892 Follies of Lovers
987 Art of Kissing
1045 A Mad Sweetheart
1089 Sex Common Sense
1166 Infatuation&OtherTales, Ben Hecht
1176 A Mad Love?
1190 What Price Love?
1195 First Love, etc.
1202 Forbidden Love
1244 HowtoWriteLoveLetters
1247 Psychology of Love & Hate. Leo Markun
1249 Best Jokes About Lovers

Murder

27 Last Days of Condemned Man. Hugo
38 Dr. Jekyll & Mr. Hyde. Stevenson
66 Crimes of the Borgias
149 Crimes & Criminals
162 Murders in Rue Morgue. Poe
558 Great Pirates
819 Strange Murders
824 Torquemada; Spanish Torturer. Clement Wood
883 Capital Punishment. Clarence Darrow
1019 Bluebeard & His Unhappy Wives
1042 Crime at Red Inn
1057 Truth About N. Y.'s Chinatown
1086 My Favorite Murder

Adventure

21 Carmen. Merimee
23 Great Sea Stories
152 Son of the Wolf. Jack London
288 Tales of Far North. Jack London
333 Mulvaney Army Stories. Kipling
482 5 Weeks in Balloon
485 Voyage to the Moon
516 Real Adventures
559 Robinson Crusoe
602 Mysteries of Egypt's Pyramid
698 Tales of Chicago Streets, Hecht
770 Adventures of Kit Carson, Frontier Hero
795 Gunga Din. Kipling
797 20 Years Among African Negroes
927 Stolen Bacillus, etc. H. G. Wells
939 Poe's Tales of Imaginative Science

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must be sold to make room for the new series!

Before we can begin to publish our new, larger, more expensive books we must clear our warehouses of stock on hand. Three million Little Blue Books won't last long among the millions of readers who know and love them. If you don't get your supply during this present sale you will have lost your last opportunity to buy masterpieces of the world's thought at 5c a book. Readers who know the educational value of these volumes will order liberally. To move them quickly, we prepay postage on these remaining Little Blue Books. Get them at 5c each, postage prepaid.

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681 Spelling Guide
682 Grammar Guide
683 Punctuation Guide
696 How to Pronounce Proper Names
697 Words Often Mispronounced
734 Useful Phrases
821 How to Improve Your Vocabulary
822 Rhetoric Guide
823 Composition Guide
855 How to Write Letters
902 Foreign Words
986 How to Debate

Sex Hygiene

14 What Every Girl Should Know
91 Manhood Facts
127 What Expectant Mothers Should Know
536 What Women Past 40 Should Know
653 What Every Boy Should Know
654 What Young Men Should Know
655 What Young Women Should Know
656 What Married Men Should Know
657 What Married Women Should Know
661 America & Sex Impulse. Theodore Dreiser
689 Woman's Sex Life
690 Man's Sexual Life
691 Child's Sexual Life
692 Homosexual Life
717 Modern Sex Morality
726 Venereal Diseases
800 Sex in Psycho-Analysis. Wood
804 Freud on Sleep & Sexual Dreams
846 Womanhood Facts
903 All About Syphilis
904 Sex Symbolism
950 Sex Determination
1250 Judge Lindsey on Companionate Marriage

Women

69 Mary, Queen of Scots
77 What Men Learned About Women
106 Frenchwomen's Daring Views of Life
123 A King's Mistress
163 Sex Life in Greece
177 Subjection of Women
189 Eugenics Explained
196 Marquise: Passion
208 Debate: Birth Control
209 Modern Aspects of Birth Control
221 How to Know Women
223 Wife of a King. Jack London
229 Ridiculous Women
286 Ancient Prostitution
292 Mlle. Fifi & Others
304 What Women Learned About Men
417 Nature of Dreams
556 Hints on Etiquette
644 Women Who Have Lived for Love
718 Great Women of Past
730 Mistresses of Today
731 Differences Between Men & Women
888 Memoirs of Mme. de Stael
901 Women: Eternal Primitive. Fielding
922 A Wife's Confession
947 Queen of Spades
955 Italian Tales of Heroism & Love
1017 Without Benefit of Clergy. Kipling
1043 A Study of Woman
1044 Another Study of Woman. Balzac
1046 Coquette vs. a Wife. Balzac.
1067 Splendors of a Courtezan, Balzac
1070 How to Fight Nervous Troubles
1079 Phallic (Sex) Symbols in Religion
1092 Simple Beauty Hints
1096 How to Dress on a Small Salary
1111 Medieval Prostitution
1113 Love for Many Angles
1122 Degradation of Women
1135 Modern Prostitution
1167 Sinister Sex, etc.
1177 Woman & New Race
1182 Cosmetic Recipes
1193 Woman's Way, etc.
1209 Charming Hostess
1212 Marriage & Morals in Soviet Russia
1219 How to Make Homes Homelike
1133 Better Meals for Less Money

Marriage

43 Marriage vs. Divorce
83 Evolution of Marriage
176 Essays on Sex. Ellis
228 Plain Talks with the Married
645 Confidential Chats with Wives
648 Sex Rejuvenation
727 Psychology of the Affections
789 U. S. Marriage & Divorce Laws
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1197 Moral Divorce, etc.
1225 Marital Discords
1238 Beginning Married Life Right
1258 Why I Believe in Companionate Marriage

Ghosts

40 Haunted House & Brain, Bulwer-Lytton
41 Christmas Carol
122 Spiritualism. Doyle
145 Great Ghost Stories
345 Clarimonde: Ghost Lover, Gautier
940 Weird Tales. Poe
969 Supernatural Tales
996 Dual & Multiple Personality. Fielding
1075 Tales of Ghouls & Ghosts, Ambrose Bierce
1132 Witchcraft. McCabe
1153 Haunted Mind, etc.
1160 Masterly Ghost Stories
1162 Tales of Ghosts
1170 Funny Ghost Stories. Jerome

Jokes

287 Jokes About Doctors
382 Lincoln Anecdotes
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842 Best Jokes of 1925
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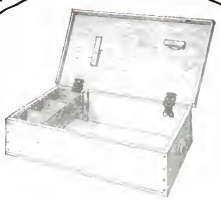

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HERE is a way to get articles like the above at little cost. And it's real fun to make them with your own hands and with your own tools.

There are 25 different Stanley Plans. The list is shown in the centre of this page. Each plan tells you just how to make the object—every step—how to select and cut the wood, how to assemble the job, how to sandpaper, paint and finish it.

Here is the complete list of the Stanley Plans No.

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11c—Book Stand
12c—Smoking Cabinet
13c—Kitchen Cabinet
14c—Sewing Cabinet
15c—Cedar Chest
16c—End Table
17c—Tea Wagon
18c—Model Sailboat
19c—Flat Bottom Rowboat
20c—Combination Kitchen Seat and Step Ladder
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To do your best work you need good tools — of course! Practically every carpenter uses Stanley Tools. Manual Training classes, too. Stanley makes the most complete line.

Buy your Stanley Plans from your hardware dealer. If he cannot supply you write to us. Send 10c for each plan and ask for a free catalog of Stanley Tools. Address—The Stanley Works, New Britain, Conn.

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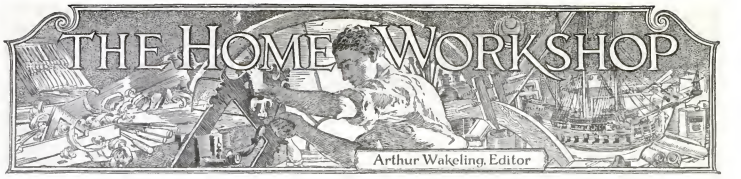


A Pirate's Chest *to Hold* Your Treasures

It Can Be Made Easily at Small Cost for Materials

Treasure chests are in great demand for their decorative quality. They hold anything from firewood to silverware

PIRATES, treasure, jewels, Spanish galleons, romance, adventure on the high seas—all these are vividly suggested by the ancient chests of dull brown oak, clasped with bands of iron, that are now so highly prized as decorations for the home.

Almost everyone would like to have one of these time-worn, battered old strong boxes, but they are practically unobtainable except in expensive reproductions.

"Why not make one?" you say.

Why not, indeed? It is a simple task compared to the constructing of almost any other piece of furniture. The chest itself can be nailed together, and the effect of hand-forged metalwork may be obtained in a number of ways ranging from the use of thick cardboard, wallboard, wood or gesso to real wrought iron. An excellent idea of what the amateur can accomplish in this way was given last month in an article by F. N. Vanderwalker on turning cheap barn door hinges into hand-wrought hardware.

Two designs for treasure chests are offered. Both were prepared by William H. Varnum, Associate Professor of Applied Arts in the University of Wisconsin and one of the foremost authorities on design as applied to the industrial arts. The details of the construction and the hints on building the chests were worked out by Charles A. King, author of King's series of books on woodwork and carpentry, who has been for many years one of the leading manual training teachers.

A blueprint has been prepared to give the details of the chest illustrated in Fig. 1 on a larger scale and more completely than is possible here. On the blueprint is a complete list of materials, a list of tools and a summary of operations. If you wish to build this chest, it will pay you to obtain the blueprint by sending 25 cents to the Blueprint Service Department of POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York. Ask for Blueprint No. 78, or use the coupon on page 93.

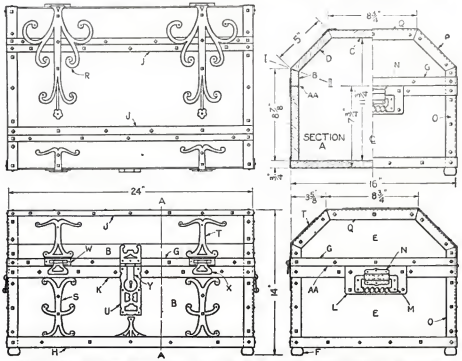


Fig. 1. The top, front and two end views of an ornamental treasure chest. The fittings may be thin plywood, wallboard, linoleum, gesso, sheet lead, copper or real wrought iron

THE design of the chest, shown in Fig. 1 and more completely on the supplementary blueprint, makes it peculiarly suitable for household or gift purposes. As a treasure chest it may not perplex a determined burglar, but as a hope chest it will safely guard its contents from prying eyes.

The chest itself may be made of any kind of wood and stained as desired. Red oak, however, is recommended; it bears out the romance of the oaken chest and the wood is not too hard for the home worker to handle. (*Continued on page 98*)

How *to* Build *an* Electric Set

Assembled from Standard Parts, This Sensitive and Selective Set Gives Superb Tone and Great Volume

By ALFRED P. LANE

HERE is a new and remarkable electric radio receiver especially designed for construction in the home workshop. It is sensitive. The selectivity is of a very high order, and the great volume, combined with true-to-life tone quality, will prove a revelation to anyone who has never heard a receiver using such tremendous power. Yet the alternating current hum has been reduced almost to the vanishing point, without sacrificing tone quality on the low notes in the slightest degree.

Full electric operation has brought up several important problems in design and construction. The question of how to control the volume, a relatively simple matter with battery operated receivers, is one of them. With battery operated sets you can turn down the filament current of the radio-frequency amplifier tubes, and the job is done. But you can't do that with alternating current tubes; first, because the control necessary to accomplish the result would be needlessly complicated, and second, because turning down the filament current of one tube would throw the grid biasing and plate voltage circuits out of adjustment.

By-passing the audio transformer windings is bad, too, because it upsets the tone quality through affecting the amplification of the transformer and because it allows the detector tube to become heavily overloaded on strong signals.

We wanted to adopt the modern drum dial control on the new set but didn't want to have the usual trouble caused by the antenna coupling, which makes it impossible to get the first and second stages to tune alike on different antennas.

This article, first in an unusual series, describes our new electric receiver, which has been tested and approved for home construction by the Popular Science Institute of Standards

BOTH the volume control problem and the antenna detuning problem have been solved in the new receiver by the use of an additional tube in an untuned stage of radio-frequency amplification. As an amplifier it does not accomplish very much, but it allows the two tuned stages to be operated at the very peak of efficiency, which isn't possible in any other way without using additional controls. The extra tube does give an increase in volume when the set is used on short indoor or outdoor antennas.

The tuning units are all exactly alike and are so constructed that a cam fastened on the condenser shaft moves the primary farther and farther away from the secondary when you tune to the low waves. The result is more than normal volume on the high waves and extraordinary selectivity on the short waves.

The detector circuit is tuned by a separate drum, because it is extremely difficult to get the detector circuit to tune exactly like the radio-frequency stages.

Shielding is used on all tuned stages to increase the selectivity and because it makes the balancing much easier.

Satisfactory full electric operation means that the entire receiver and power supply unit must be designed as a complete system. This is particularly true if the power unit is to be constructed throughout with fixed resistances so that there will be no voltage adjustments or biasing adjustments.

The receiver shown on these pages is part of such a system. Next month we will show the combined power amplifier and current supply unit that is connected to the leads from the receiver shown on these pages.

As you will note from the diagrams, the electric receiver itself includes the three tubes operating at radio frequency, the detector stage, and the first stage of audio amplification. The second stage of audio amplification, which is included in the power supply unit to be described next month, is one of the most powerful ever designed for home construction. So this month's receiver plus next month's

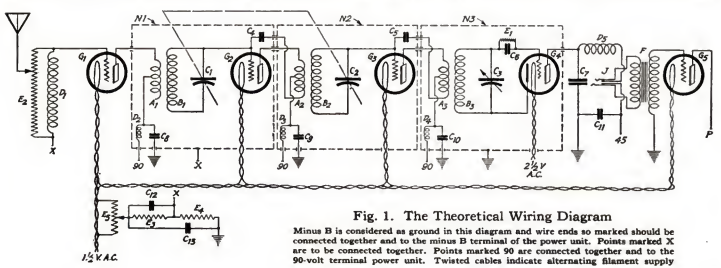


Fig. 1. The Theoretical Wiring Diagram

Minus B is considered as ground in this diagram and wire ends so marked should be connected together and to the minus B terminal of the power unit. Points marked X are to be connected together. Points marked 90 are connected together and to the 90-volt terminal power unit. Twisted cables indicate alternating filament supply

current supply and amplifier unit will give you as fine a complete electric radio receiver as it is possible to construct.

The receiver is designed so that you can take advantage of the great volume and marvelous tone quality to reproduce the modern electrically recorded phonograph records. Any standard electric pick-up device can be used. Just turn on the set

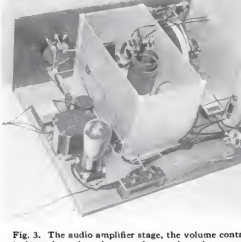


Fig. 3. The audio amplifier stage, the volume control, and the jack used to play phonograph records and to reproduce voice

in the usual way, plug the cord from the pick-up device into the jack located beneath the volume control knob at the right end of the panel, and control the volume of the phonograph music by means of the special volume control supplied with the pick-up device. You can instantly shift back to radio music by pulling out the plug. Immediately, any station that happens to be tuned in will be heard in the usual way.

YOU can even make up broadcast programs to amuse your friends by plugging a pair of headphones in place of the pick-up device. Then talk into one of the headphones and your voice will come rolling out of the loudspeaker with a volume that will startle you.

You will need these parts to build this section of the complete electric receiver:

A1–B1, A2–B2, A3–B3—tuning units.
C1, C2, C3—variable condensers, .00035 mfd. capacity.
C4, C5—adjustable balancing condensers.
C6—grid condenser, .00025 mfd. capacity with clips.
C7—bypass condensers, .001 mfd. capacity.
C8, C9, C10, C11, C12, C13—bypass condensers, ½ mfd. capacity.
D1—radio, frequency choke coil, 250 millihenries inductance.
D2, D3, D4, D5—radio-frequency choke coils, 85 millihenries.
E1—grid leak, 2 megohms.
E2—potentiometer, 500,000 ohms (must be nonінductive and noncapacitive).
E3, E4—fixed resistances, 400 ohms each.

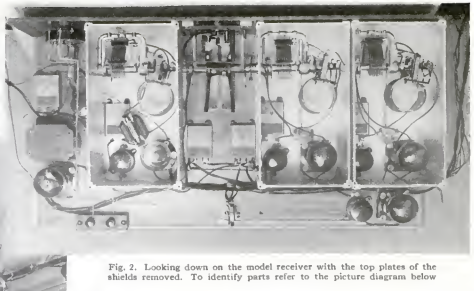


Fig. 2. Looking down on the model receiver with the top plates of the shields removed. To identify parts refer to the picture diagram below

E5—potentiometer, 6 ohms.
F—audio-frequency transformer.
G1, G2, G3, G5—standard X-type vacuum tube sockets.
G4—special socket to fit UX 227 vacuum tube.
J—double circuit jack.
K—illuminated drum dial.
L—laminated inlaid walnut wood or composition panel, 7 by 24 inches.
M—wood baseboard ½ by 12 by 23½ in.
N1, N2, N3—standard aluminum box shields, 5 by 6 by 9 inches.

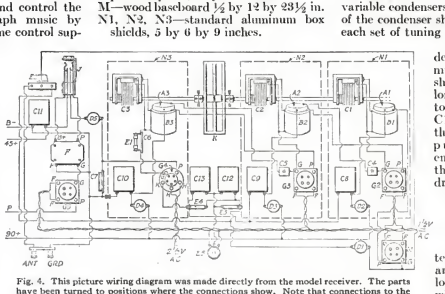


Fig. 4. This picture wiring diagram was made directly from the model receiver. The parts have been turned to positions where the connections show. Note that connections to the tuning units should be made to the lugs provided and not directly to the coils. Find the lug that connects to the point indicated on the coil. The soldering lugs are easily located

One piece of ¼ inch round brass rod 10¼ in. long, a supply of flexible enameled fabric covered wire of standard diameter, and 10 feet of No. 10 flexible enameled fabric covered wire; three lengths of regular bus wire; two binding posts, screws, etc.

THE tuning units A1–B1, A2–B2 and A3–B3 used in the model receiver are supplied mounted so that they can be attached to the frames of the variable condensers. Cams to fit the ends of the condenser shafts are supplied with each set of tuning units.

The variable condensers C1, C2 and C3 must have detachable shafts so that a single long shaft can be used to operate condensers C1 and C2, and so that the shaft of C3 can be pulled through far enough to engage with the coupling on the drum dial.

Part E2, the 500,000-ohm potentiometer, must be noninductive, and the capacity between the terminals and the resistance element must be low, as otherwise you will get no control of volume on loud stations. Do not use any of the compact all-metal types at this point in the circuit. They are designed for a different kind of service and will not work as a volume control in this particular arrangement.

Blueprints and Information

BLUEPRINT No. 79, describing in still greater detail the construction of this section of our modern and extraordinarily powerful electric radio receiver, can be obtained for 25 cents (see page 93). A complete list of parts approved by the Popular Science Institute of Standards for use in building the set shown here will be sent with each blueprint or will be mailed without charge to those readers who do not wish the blueprint. Address requests for information to: Radio Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York.

Assembling the Set

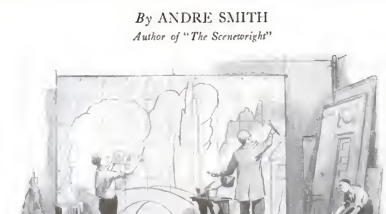
THE first job is to fit the drum dial K to the panel. A template showing the exact location of the screw holes and the opening is supplied with the dial. Use a jig saw to cut out the piece that must be removed. The dial should be set ½ inch off the center of the panel toward the right-hand end. This is necessary to allow the aluminum shield boxes N1 and N2 to stay within the limits of the panel. In the model set the drum dial is set so that the shaft (*Continued on page 109*)

Scenecraft—Painting the Set

Colors and Brushes—Outlines, Shadows, Stippling and Spattering—How to Get Brilliant, Posterlike Effects

By ANDRE SMITH
Author of "The Scenewright"

THE term "scene painting" dates back to those days, not so very long ago, when a stage set was a painted picture composed of a back drop and a series of wings or flats, upon which were painted (often in rather amazing perspectives) the elements of the scene, exterior or interior. But with the advent of the "plastic" setting, that is, a setting in which as many as possible of the elements of the scene are real, or seem to be real, scene painting refers now mostly to the preparation of the back drops or the flanking side pieces of an exterior set.



Painting a back drop. The scenewright at the left is drawing the outline with charcoal, the painter is boldly brushing in the foliage, and the man at the right is mixing powdered tempera colors with water. A cardboard model of the complete scene stands on the table

The change from the painted room to an actual one has made the scenewright's job more a matter of construction than clever pictorial deception. It requires the scenewright to be more like an architect or builder than the old-time scenic artist.

In writing on this subject of scene painting I must divide my remarks into two groups: the painting of (1) interiors and (2) exteriors.

The average interior set of today, when carefully designed and built with thoroughness, is to all appearances an actual room. The problem of painting it is very often not so different from the painting or decorating of an ordinary room. The requirements of the play and the particular scene for which the setting has been designed will, of course, govern the selection of a color scheme, as well as the manner in which the painting must be done. A cheerful, sunny country-house interior will demand an entirely different selection of color and the application of that color than will a room in a sordid city tenement.

ALTHOUGH this may seem obvious, I have, nevertheless, seen a well-designed set of the latter type fail to create the desired grim atmosphere of poverty and hardship merely through the use of the wrong color for the walls and because of the neatness with which the paint was applied. Although the interior set calls most frequently for nothing more than a house painter's skill, there are many occasions when the old scene painter's artistic touch is necessary for creating the illusion of age, atmosphere and charm.

For fear that the reader should think that the task is beyond him, let me assure him that it is by no means as difficult as he may think. And strangely enough, the reason for most failures among amateur scene painters comes not because they cannot paint well enough, but because they paint *too well*. They paint too carefully. They cover the thin paper or muslin-covered flats so smoothly that instead of creating the illusion of solidity, the very slickness of their job results merely in a weak sort of tinting.

EVERY scene painter must remember that his settings are always seen under conditions that are far more favorable than he imagines. From the viewpoint of a person in the audience the room is seen through the advantageous dark frame of the proscenium arch: its plasticity gives it at once the suggestion of reality; the lighting helps the illusion; the furniture enhances the effect of solidity; and the actors bring to the whole setting the necessary quality of life.

If I appear to contradict myself when I say that the scene painter should not work too carefully and at the same time not slight his job, I wish merely to make the distinction between applying the paint with the unimaginative sweep of the house painter instead of the suggestive brush strokes of the artist. It is better to apply the paint with short, broken brush strokes, a stippling, or anything to suggest a textural quality. If the suggestion of rough plaster is called for, the brush strokes can be freely handled, but for the more usual wall finishes it is best to use a two-coat method consisting of a flat underpainting and an overpainting in another color, stippled on with a small brush or spattered with a large brush. Spattering is the quickest and the most satisfactory way; if you are unfamiliar with the way it is done, your local painter will, no doubt, be able to show you. The brush should be only slightly charged with paint, otherwise the spatter spots will be too large and uneven.

The advantage of this duo-tone painting is that when it is used in conjunction with proper stage lighting the color scheme of a room can be changed merely by the use of warmer or cooler lights, that is, by the use of amber bulbs or white daylight bulbs.

THE experienced scene painter, anticipating the effect of his stage lighting on the two-color walls, is often able to make one set do for two different interiors, merely by a slight readjustment of doors, the introduction of a flat to screen a window, and a complete change of color in the stage lighting.

The actual painting of the set had best be done on the stage with the setting in place. Unfortunately, most amateur play-producers are denied the use of the stage until a night or so before the presentation of the play, nor is there sufficient space otherwise available to allow for anything more than the (*Continued on page 100*)

Are You Taking Part in Your Neighborhood Theatricals?

IF YOU are, you will find invaluable hints on stage carpentry, scene painting and kindred subjects in the articles Mr. Smith is writing for POPULAR SCIENCE MONTHLY. The present article is the fourth of the series.

If you have not joined your church, club, school or neighborhood players, you are missing something worth while, for amateur theatricals have become a great pastime in every community. And no one is more welcome in a group of players than the man who is handy with a hammer, saw and paint brush.

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Old Colonel Wellman left a legacy to you!

'WAY BACK in the early seventies, before most of us were born, a fine old Southern gentleman, Colonel James N. Wellman, was mellowing tobacco, by his own secret method, as tobacco had never been mellowed before!

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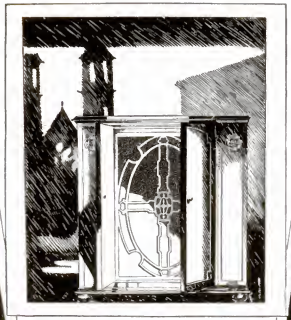
GRANGER ROUGH CUT

A TOBACCO MADE AND CUT FOR PIPES . . . 10 CENTS

QUALITY AMPLION



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Walnut cabinet with fine piano finish, 34″ x 33″ x 18″. New balanced armature unit with straight bar Cobalt steel magnets. This steel has the highest magnetic flux density of any metal. 20 ft. cord. Combination cone and sound board.

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Much depends on the care taken in constructing the model's fuselage

Model Airplane Design

How to Dimension Wings and Other Parts—Ways to Get Steady, Long Flight

By J. D. BUNCH *and* A. F. KOCH

IN THE design and construction of model airplanes there are some simple rules that should be kept in mind. These concern the stability of the model and the determination of wing and tail surfaces, their angles, sizes and location.

In the question of the longitudinal stability of a "pusher"—a model with the propeller or propellers in the rear—that has two lifting surfaces, the forward wing should have a greater angle of incidence, or attack, than the rear wing. Thus in a steep climb the forward wing reaches the "burble" point—the point at which the air stream breaks up and loses lift—before the rear wing and will sink to a normal position at which the power can continue to drive the plane forward. Conversely, in a dive, the rear wing is at an angle to the flight path more nearly approaching the negative than the front wing. Thus the rear wing loses lift and enables the forward wing to lift the nose to a normal attitude.

The center of pressure of the wing curve—that is, the point along the profile at which the lift is concentrated—is theoretically over the center of gravity, the point along the fuselage at which the weights, fore and aft, balance. As the center of pressure is removed from the center of gravity, the corrective movements of the airplane cover a greater elapsed time, and consequently the dives and climbs are increased between moments at which the airplane assumes the correct flight attitude.

FORTUNATELY, in model airplanes the wings can be slid back and forth along the fuselage until they reach a point where the centers of pressure and gravity coincide. The correcting movements are then not perceptible and the airplane is said to be stable in flight.

The best method of securing longitudinal stability in a tractor is as follows: Rig the stabilizer, which should be a non-lifting surface, at a negative angle. In relation to the air stream in normal flight attitude, it is depressing. Then rig the wing, or lifting surface, so its center of pressure is slightly to rear of the center of gravity. The object is to arrange the wing in such a manner that the depressing action of the tail is counterbalanced by the nose heaviness at a normal flying speed. With this arrangement at high speeds, such as in a dive or with motor wide open, the airplane tends to climb. At low speeds, as at the top of a steep climb, when the plane nears a stalling attitude, it tends to assume the dive. As the center of pressure approaches the ideal position in relation to the center of gravity, the correcting movements of the airplane become smaller and smaller until the plane is stable.

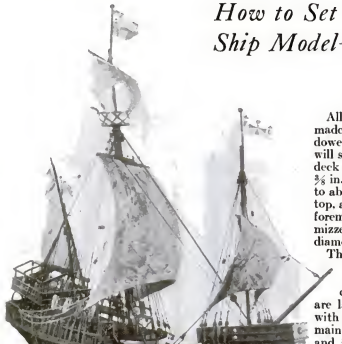
LATERAL stability is best obtained by rigging the plane with a dihedral angle. Do not use an excessive dihedral, however, as it entails too great tip losses and results in decreased lift. The pendulum action of the dihedral angle is best overcome by bringing up the center of gravity. Very stable airplanes have been made with the entire weight of the machine built above the wing, as in the famous Junkers low-wing monoplanes.

In propeller design there are two general types, one with wide and the other with narrow blades. The modern tendency is toward (*Continued on page 104*)

A *Santa Maria* That Is Easy to Build

How to Set Up the Rigging of Our New Ship Model—Blueprints Make It Simple

By E. ARMITAGE McCANN



The *Santa Maria*, with her yards braced in as if for a quartering breeze, is a decoration of unforgettable beauty

WHILE this is the third part of the story of how to make what many consider the most desirable ship model it is possible to possess—the *Santa Maria*—it is not too late for anyone to begin work on a model of his own.

The hull and deck superstructures, which were described in the preceding installments, can be built easily from full size drawings contained on Blueprints 74, 75 and 76, which may be obtained from the Blueprint Service Department of POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York, for 75 cents. They show the construction in great detail and have as well a complete bill of materials. The December, 1927, and January, 1928, issues, in which the two preceding parts of the article were published, also are available for those who wish them at 25 cents each.

The desirability of this model of the flagship of Columbus lies in the fact that she is really what the world's most famous vessel must have looked like and not the impossible ship usually depicted.

Those who have completed their models as far as described last month now have only to make the spars, sails and rigging.

All the spars can best be made from straight-grained dowel sticks. The mainmast will set about ¾ in. into the deck and extend 17 in. It is ⅝ in. at the base and tapers to about one half that at the top, as do all the masts. The foremast is 9 in. long and the mizzen 7 in., each ¼ in. in diameter at the base.

The main yard is in two pieces of ¼-in. dowel, each 8 in. long. They overlap 4 in. where they are lashed (bound) together with four cord lashings. The main topsail yard is 4 in. long and 3/16 in. in diameter; the fore yard is 6 in. long and a bare ¼ in. in diameter, and the lateen yard at the mizzen is in two pieces, each 6½ in. long by ⅜ in., overlapping 2½ in. All the yards taper to nearly half their diameter at the ends. They and the masts should be stained and lightly varnished a reddish brown to represent antique pitch pine.

The foremast should be almost upright. The mainmast lies aft at an angle of 6 degrees, the mizzen at about 11 degrees, and the bowsprit rises at an angle of about 32 degrees.

The bowsprit is ¼ in. in diameter, tapered; it extends 5½ in. from the deck. The hole to step it is bored into the hull through the square hole in the forecastle deck, close up to the right side of the foremast. Have it firmly fixed and nailed down if necessary so that it will not lift from the strain of the forestay.

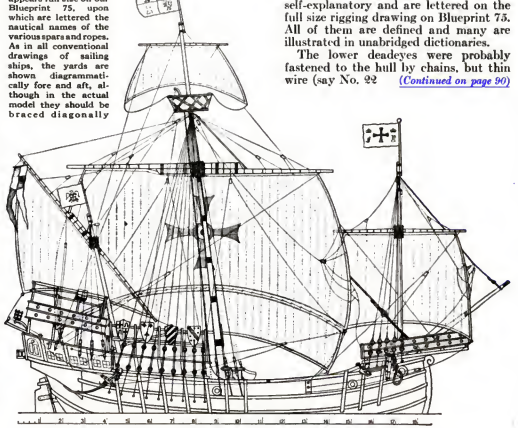
THE chainwales (the modern name is channels) to spread the rigging are wooden platforms ¾ in. wide, 4½ long and 3/16 thick. They extend from the first skid abaft the mast to the fifth. They are notched inside to fit on the skids and lie on the upper wale. The outside edge of each has nine equidistant notches to take the chains.

When these are on it will be necessary to make 56 heart-shaped deadeyes, ⅝ in. high, 3/16 wide and ⅛ thick. I believe they should have three holes each, but it is possible that the original deadeyes had only one large one. They have a groove round their narrow edges.

For the sake of brevity and clearness, a few nautical terms must be used in describing the rigging. Most of these are self-explanatory and are lettered on the full size rigging drawing on Blueprint 75. All of them are defined and many are illustrated in unabridged dictionaries.

The lower deadeyes were probably fastened to the hull by chains, but thin wire (say No. 22 *(Continued on page 90)*

The rigging plan. This appears full size on our Blueprint 75, upon which are lettered the nautical names of the various spars and ropes. As in all conventional drawings of sailing ships, the yards are shown diagrammatically fore and aft, although in the actual model they should be braced diagonally



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6. What is an electric current?
7. How was petroleum formed?
8. Do electrons really move through wire when an electric current is flowing through it?
9. What physical changes in your body are produced by fear?
10. How do muscles exert power?
11. What are X-rays?
12. Can we see atoms with a microscope?
13. Why does heat expand things and cold contract them?
14. Why does the moon appear to change its shape from time to time?
15. What is the brain made of?
16. Why is it possible that the inside of the earth is growing hotter instead of colder?
17. Why is frost more likely on a clear night than on a cloudy one?
18. Does thinking use up the thinker's energy?
19. Which travels faster, electricity or light?
20. What simple test will distinguish wool from cotton?
21. What makes the noise of thunder?
22. Why would men ultimately suffocate if all the green plants were killed?
23. Does the boiling of water remove the impurities in it?
24. How do the living cells of the body get the energy with which to do their work?
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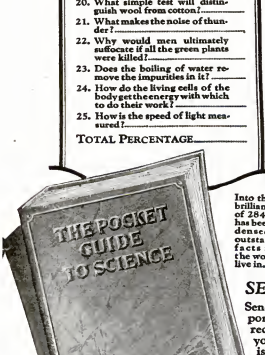

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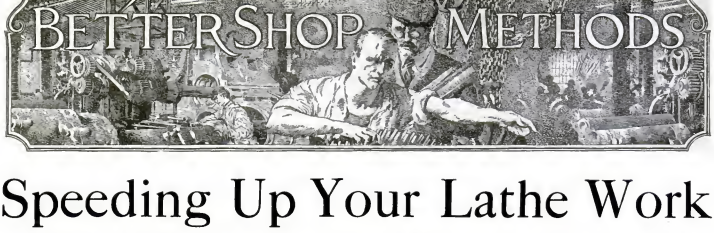

Speeding Up Your Lathe Work

Hints on Tools—Centering, Facing, Threading and Cutting-Off Operations—Templates and Gages—Drilling and Boring

By H. L. WHEELER

MACHINISTS who take the lead in lathe work are those who know and use many time- and labor-saving kinks. Maximum production, with due regard for quality, is what counts in the modern shop, especially on lathe work.

Every good lathe operator has his own bag of tricks. There are, indeed, hundreds of kinks well worth knowing.

To the young machinist who wishes to make a specialty of lathe work I suggest as the first step to becoming a topnotcher that he spot one or two men in the shop who are recognized as first-class workmen. Observe their work and any special methods they use.

Fig. 1. Setting a lathe tool by placing a size block between it and the tail center. Compare with Fig. 4

It is the custom in many shops where large numbers of engine lathes are used to keep an operator assigned to one individual machine. Workmen seldom shift from one lathe to another. If you find yourself so situated, you will profit considerably by cleaning and oiling your lathe regularly and keeping it in good repair. Adjust the gibs on cross slide and compound rest so that these members will move freely and yet have no side play. It is a great handicap in respect both to quality and speed to have any moving parts bind so that undue exertion is necessary to move them.

THE speed at which the counter shaft runs is an important consideration. Some lathes run too fast and some too slow for the work they are required to do. This can be remedied by having pulleys of the correct size on the line shaft to give the maximum and minimum spindle speeds. The correct cutting in different jobs in feet per minute then can be easily approached by using the various speed changes on the lathe.

The spindle, when in open belt, should turn easily with a light pull by hand. If it should pull hard, a part of the power required to run the lathe is not being delivered at the tool point under heavy cuts and there is a consequent loss of time on each job. In fact, the smoother the lathe runs, the better the quality and the larger the quantity of work you can turn out.

Most lathe men who are required to handle a large variety of work on the same machine day after day have a set of tool holders and often a collection of forged tools shaped for special operations. Whatever the design of your collection of tools, it is always an advantage to have them sharp. If you happen to be called upon for a rush job, your tools are then ready; otherwise it may mean a trip to the emery wheel and perhaps a wait for one or two other men ahead of you. There are times, such as just after you have started a long cut on some job, when you can step up to the wheel and grind three or four tools. New tool bits are long enough to have a cutting point on both sides, so that when one end is dull you simply have to reverse it in the holder, thus saving time.

Some men have a prejudice against tool holders and high-speed tool bits and often express a preference for the forged tool. It is true that the forged tool has advantages in certain cases, but for a large part of the work the tool holder is just as good.

The principal difficulty some mechanics experience with tool bits is in the grinding. A man will sometimes grind the clearance angle with the base of the tool bit instead of with the base of the holder. He then finds that when the bit is placed in the holder at an angle of about twenty degrees, the tool has no clearance or, in any event, not enough. Don't forget that the clearance angle must be ground with the base of the tool holder.

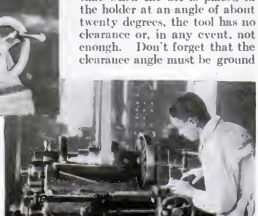

Fig. 2. A true center line drawn on the faceplate can be transferred to the work with a surface gage

Another fault I have noticed is the practice of grinding the clearance angle on the face of the wheel. This produces an effect like the upper tool shown in Fig. 3, page 96, which is not the correct form. The clearance angle should present a straight line as shown in the lower tool. The first view is exaggerated somewhat to emphasize the principal defect of this method of grinding a tool. It clearly demonstrates that the point of the tool, where great strength is required, has been weakened; having no (*Continued on page 96*)

OTHER timesaving shop ideas are contained in the continuation of the Better Shop Methods Department, which you will find on pages 86, 96 and 97.

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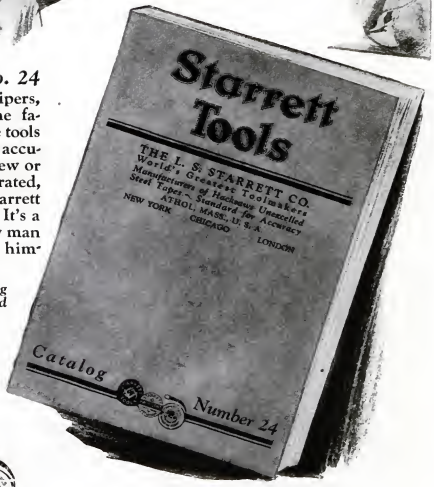

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Shop Kinks That Save Time

Milling Square Ends on Cold Rolled Bars—Measuring Shoulders of Studs—A Prickpunch Magnifier—Other Short Cuts

MILLING square ends on the cold rolled rods used on the gates of elevated railway cars and for other purposes proved a problem in a large repair shop until the fixture illustrated in Figs. 1 and 2 was devised.

The rods are from ¾ to 1½ in. in diameter. Both ends of each rod must be squared, and it is important that the squares be milled in the same plane. Formerly these rods were milled one at a time by the use of the dividing head. Now 60 percent of the time is saved.

The fixture is composed of three separate housings, A, B and C, made out of old angle plates. The base of each is tongued and fitted to the slot in the milling machine table. A slot F is milled in each to take the largest rods to be machined; to accommodate smaller sizes, adapters like G and H are screwed on.

Plates A and B are alike in every detail, but plate C has the added feature of an indexing slide D, operated by thumbscrew J and moving in the groove E.

In operation, the housings are spaced to suit the length of rods to be machined and bolted to the milling machine table. Straddle milling cutters are set to the required width of the squares and the first cut taken. The rods are then turned end for end in the fixture, and the indexing slide D is screwed in to hold the newly cut faces at right angles to the cutting position. For the third and fourth operations, the same reversing is done. This fixture was designed by Frank Kutolski and the writer.—ALBERT M. THOMAS.

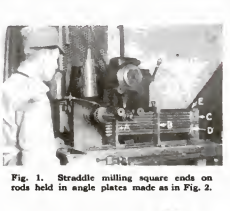


Fig. 1. Straddle milling square ends on rods held in angle plates made as in Fig. 2.

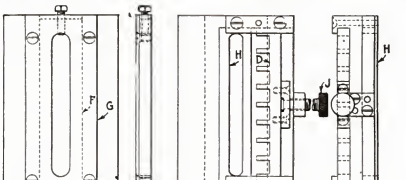


Fig. 2. Two of the housings are plain, but the third carries an indexing slide. Rods of various sizes are accommodated by changing the indexing slide D and guide plates G and H

THE block illustrated in Fig. 3 is useful for measuring accurately the different lengths of shoulders on studs. For example, put the small end of the stud B in a hole D that is about .015 in. larger than it and measure over all (.505 in.); then put that part of the stud marked A in a suitable hole as at E and measure over all (.415 in.). Deduct F from G and it will give you A.—J. C. FISHER.

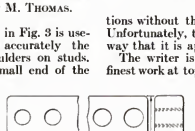


Fig. 3. How to make and use a block for measuring studs with shoulders

LAYING out and spacing center and prickpunch marks are often difficult operations without the help of a strong glass. Unfortunately, this aid is so much in the way that it is apt to be dispensed with.

The writer is enabled to lay out the finest work at top speed by the use of the "egg-of-Columbus" attachment illustrated in Fig. 4. All that is required is an ordinary lens about ¾ in. in diameter and from ⅛ to ¼ in. thick. It should give a magnification of from six to ten times but it need not be expensive, nor is it necessary for it to be a "thoroughbred" magnifying glass, as all that is required is that it gives a sharp picture over the central portion. The lens is pressed into a holder twisted from half-hard wire to fit the lens and punch shank. The holder and lens can be quickly adjusted to focus the glass on the point of the punch.

The attachment is equally useful in many cases where, instead of prickpunching, work has to be divided by lines laid out from a scale by means of a scratch awl. It can be used on a pencil, too, for very fine work in laying out locations on the drawing board.—HENRY SIMON.

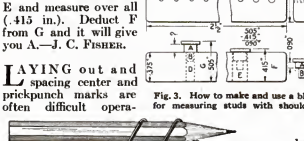


Fig. 4. A magnifying glass attached to a prickpunch or pencil insures accuracy in fine work

A TOOL for packing the stems of valves can be made from a piece of seamless tubing as shown in Fig. 5. Select a size to fit the valve and large enough inside to slip over the stem. On one end cut an opening with a milling cutter and bevel as shown.

The packing is started in the usual way. Then the tool is slipped over the stem, and, while being turned with the left hand, is tapped lightly with a hammer or mallet.—H. L. W.

IF HIGH speed steel is to be hardened for use as lathe bits and neither the origin nor the composition is known or can be easily discovered, the following method can be used successfully even if only an ordinary forge is available.

Heat the bits on a small iron plate in such a way that the nose of each sticks over the edge of the plate and is directly over the hot blast. In this way the body is not overheated. Cool the point in kerosene until it stops sizzling and drop the tool in water. While not a scientific method, this prevents cracking.—GEORGE SCHMIDT.

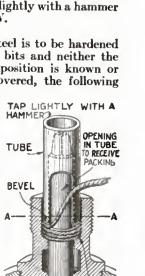


Fig. 5. A handy tool for packing valves

Simple *Build-It-Yourself* Ideas

Bookstand and Seat—Kitchen Plant Stand —A Gift Gavel—Cocoanut Ash Receiver

FOUR easily made home workshop projects are shown in the accompanying illustrations.

The convertible bookstand and seat shown in Fig. 1 was made by E. A. Zinke, of Richmond Hill, N. Y. The joints were assembled with the best quality liquid glue. Then the piece was thoroughly smoothed with fine sandpaper, given a thin coat of shellac and two coats of varnish, and rubbed to a dull finish with pumice stone and oil.

The combination flower stand and book trough shown in Fig. 2 was made by John F. Hardecker, of Brooklawn, N. J., to match the table and "server" of a breakfast suite used in the dining nook of his kitchen. The top is of finished white pine ¾ by 12 by 36 in.; the legs are of the same wood and are 2 in. square, tapered at the bottom. Because of the comparative narrowness of the stand, some bracing was necessary between the legs for stability, so a book trough was inserted. The whole stand was built in an evening. It was finished with light gray enamel and decorated with a flower stencil to match the other pieces in the breakfast suite.

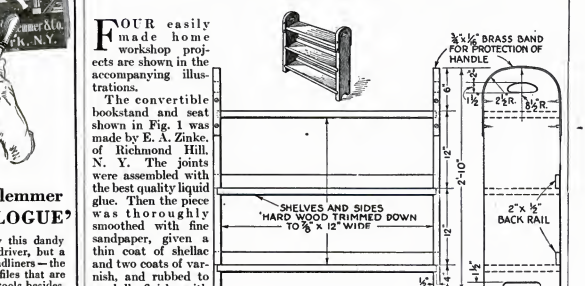


Fig. 1. A simply made bookstand that can be carried with its contents from place to place and also used in an emergency as a bench

Fig. 2. Combined flower stand and book trough for use in breakfast room

Fig. 4. Ash receiver with dumping tray

In Fig. 3 is shown a gavel, which was developed as an exercise in turning by H. B. Kellam for shop classes in a Los Angeles high school. If it is desired to make the piece still more ornamental, the surfaces marked A, B, and C may be covered with silver or other metal and suitably engraved.

The little novelty shown in Fig. 4 is an ash receiver made of a cocoanut in such a way that the tray may be tilted so as to dump its contents into the larger accumulator. When this has been done the tray automatically rights itself. The design was suggested by George D. Hugo, of Seattle, Wash.

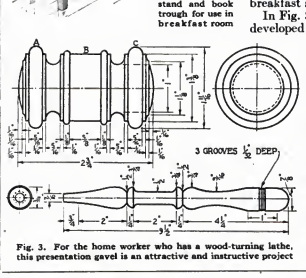
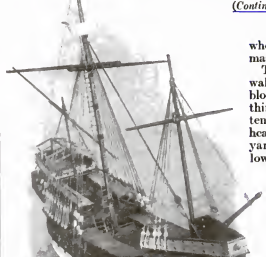


Fig. 3. For the home worker who has a wood-turning lathe, this presentation gavel is an attractive and instructive project

A *Santa Maria* Model

(*Continued from page 82*)



The model with masts, shrouds, yards, main- and forestay

soft) twisted around them with an eye in the lower end is sufficiently good. Each deadeye should sit on the chainwale, and the lower eye should be fastened to the hull about 1¼ in. below by a round-headed nail, placed in line with the shroud and in line with the other nails.

The forward rigging has no chainwales. The "chains" are about ¾ in. long and made and fastened the same as at the main. There are no deadeyes or chain-wales at the mizzen.

FOR all the rigging I strongly advise the use of linen cord, such as fishline; it looks like rope, is not "hairy," and does not stretch and slack with the weather. It should be stained a rich dark brown before use. Three thicknesses will be sufficient; one about as thick as twelve sheets of this magazine, another two thirds of that, and the finest half of that again. The latter may be stained a much lighter brown.

There should be 12 main shrouds, but the three forward ones may be omitted. They will, of course, be of the heaviest cord. The first pair (pendants) goes up one side and down the other; the others go around the mast-head and down on the same side again, starting with the forward pair and alternating the sides. Cut each pair amply long, make a loop in the middle with a thread binding, slip it over the masthead to the position shown, and, when all are on, bind them firmly on the mast.

The first three (forward of the chain-wales) are temporary, and have double blocks in their lower ends, connected with thin cord lanyards to single blocks fastened to the hull with short chains or heavy cords. The others set up by lanyards through deadeyes or hearts to the lower deadeyes. The ends of the shrouds are fastened to their hearts by passing them around with single hitches on top and then lashing with thread around the ends, so that they are all in one line conforming with the sheer of the ship. The centers of the upper deadeyes should be about 1 in. above the lower.

The forward shrouds are rigged exactly the same, but with a shorter drift between the deadeyes. There should be five on a side.

The mizzen shrouds set up with double and single blocks, the forward pair coming to the after end of the chainwales, and the other three aside to staples about 3/8 in. below the top of the bulwark, to which they are fastened by thin cord or wire.

THE blocks for the rigging, and nearly all the others, are just oblong blocks of wood with holes bored in them and the corners rounded, one hole in each direction, or in the case of double blocks, two holes together in one direction and one in the other. The sizes are determined by the holes that have to be bored in them to take the cord. Keep them as small as possible.

The mainstay should be three parts of the heavy cord twisted together. It starts above the shrouds and has a large heart turned in the other end, to lie abaft the foremast. From there it sets up, with a lanyard, through the forecastle deck to the stem.

The forestay sets up with a smaller heart to the bowsprit.

Model makers will be glad to learn that ratlines would be incorrect for the period. In place of them there is a Jacob's ladder, abaft the mast. This is easily made. First make some 28 steps from slips of wood not more than 1/16 in. square and a bare ½ in. long. Then get a double piece of the thick cord, long enough to reach from the mast top to the poop deck. Starting 1¼ in. from the loop of this and holding the two parts together, open the strands with a sharp point at 3/4 in. intervals and slip the steps through. When all

(*Continued on page 92*)

Next—A Model of the *MAYFLOWER*

THE "Mayflower" will be the next and seventh in the POPULAR SCIENCE MONTHLY *series of historic ship models. An article telling how to construct this famous model will begin in an early issue. There will be the usual supplementary blueprints.*

As in the case of the "Santa Maria," Captain McCann has gone back to original sources for data and has created a model that is thoroughly authentic and at the same time relatively easy to construct. Because of its simplicity, its picturesqueness and its historic significance, the model will appeal alike to beginners and experienced model makers.

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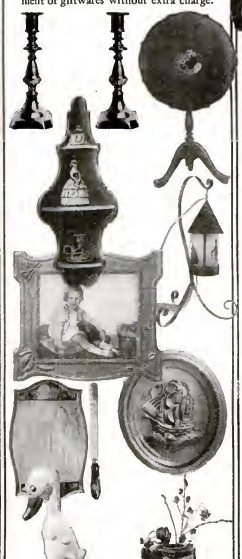

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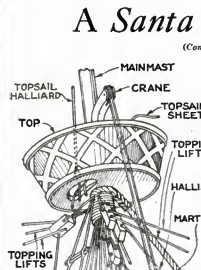
A *Santa Maria* Model

(Continued from page 90)

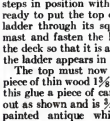


The mast top in position on the mainmast directly above the shrouds and mainstay

are in, separate the cords so that the bare ends of the steps are still through each strand, making a tiny ladder. Bind the top and bottom steps in position with thread. When you are ready to put the top on, pass the loop of this ladder through its square hole and over the mast and fasten the lower ends to staples in the deck so that it is almost upright. A part of the ladder appears in the illustration above.

The top must now be made. Cut a round piece of thin wood 1⅛ in. in diameter. Around this glue a piece of cardboard, so that it flares out as shown and is ¾ in. high. This may be painted antique white with red crisscross stripes and may have thin spline moldings top and bottom. It has a hole in the center to fit the mast very snugly where it rests on the rigging. There is another oblong hole abaft this, and three staples are set in the bottom.

The top should also be fitted with a top-crane for hoisting up fighting material, such as arrows and stones. The crane is a curved piece of wood nailed to the floor of the mast top, with a pulley or hole in the protruding end. Fasten the top down on the eyes of the rigging as illustrated above



How to whittle the ship's boat. It is only 3¼ in. long

with glue and a small nail through to the mast.

The sails are the next thing to be considered. Any thin "canvassy" looking material, linen for preference, will do. Their size and shape can be seen in Blueprints 75 and 76. Note that the mainsail proper has a bonnet, which is a primitive provision for reefing, laced to it.

The canvas looks best if it is stitched in rows about ¼ in. apart to represent seams. The edges should have a narrow hem and may have a cord sewn to that.

As the rest of the model is being antiqued, the sails also should be treated. Strong tea makes a good base color, with other browns streaked in while the sails are wet, and a restrained touch of green and perhaps red.

Fasten the sails to the yards with heavy brown thread or thin cord. Use a marline hitch, which is the same as a buttonhole stitch. To the leeches of the main- and fore-sails are fastened thin cord and bead crow's-feet. Those leading abaft are called martinets and those forward bowlines. At the bottom corners of all make loops in the cord or sew on little rings.

The yards are held to the masts by parrals. A turn of cord will serve for this, but the correct method is to use rollers (beads) and battens (four rows of five beads and five little battens) to keep them apart, with thin cords through both beads and battens. This is shown in a detail on Blueprint 75.

Halyards are used to suspend the yards. There should be two of heavy cord at the main, hitched to the yard near the middle and leading through blocks lashed to the mast, over the shrouds, then down to double blocks, which are connected by thin cords to other double blocks fastened to staples in the deck.

THE yards are kept horizontal with topping lifts, two to a side at the main and one at the fore. The cords are tied to the yard, pass through single blocks and back to the yard; then the blocks other cords lead through blocks at the masthead and to the deck.

From the martinets other thin cords lead through masthead blocks to the deck and cords lead from the clews through blocks lashed under the yards to the deck.

To the clews heavy cords are hitched, one part leading aft to a large single block to form a sheet and the other forward for the tack. The tack goes through a hole in the forward bulwark and back through another hole beneath and then forward to form the fall of the fore sheet, its end being fastened to a staple beneath the two holes. A strengthening piece may be glued to the bulwark where these holes come, called a chestree. The fall of the main sheet starts from a bolt in the hull, abaft and below the chainwale, and passes back to a hole in the after bulwark. There will also be a single heavy cord from the clew of the bonnet leading aft.

The main brace pennant is from the yardarm to a large block and its fall comes from a staple in the hull to a hole in the after bulwark.

The fore brace pennant is similar but shorter, and its fall leads from a bolt in the forechains to the post upholding the cow bridge on the opposite side of the deck.

THE lateensail at the mizzen has a similar but smaller parral; a single halyard; an elaborate crow's-foot leading to the mainmast head; a single or double sheet to a short boom extending over the stern, and a tack made fast to the main rigging.

The main topsail is but a small sail. A cord parral and a single halyard making fast to a staple in the top will hold it. The sheets also lead to other staples in the top, and light braces lead through single blocks lashed to the mizzenmast head. There should also be preventer backstays from the masthead to blocks abaft the mizzen rigging.

Models most frequently have their yards directly across the ship, but I prefer in a case like this to have them slightly diagonal, or braced in as if for a quarterly breeze, and for this model I stiffened them and bellied them out. This I accomplished by coating the after sides with thin, tinted cement, allowing them out with an electric fan while drying.

The anchor cables are three parts of the thick cord laid together, or other heavy cord; they are hitched to the anchor rings, the ends being glued and nailed inside the hawse pipes, forward and aft.

The flukes of the forward anchors are lashed to staples in the cow bridge and their stocks to the fore rigging. The after anchors are lashed to the chain- *(Continued on page 108)*

Blueprints for Your Home Workshop

ANY ONE of the blueprints listed below can be obtained for 25 cents. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available.

Popular Science Monthly
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Send me the blueprint, or blueprints, I have underlined below, for which I enclose.....
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THE SHIPSHAPE HOME

Getting More Heat from Your Furnace

By ORVILLE H. KNEEN

"IF YOUR furnace fails to do its duty when the thermometer drops way down," said a heating engineer recently, "it may be the fault of the furnace, or it may be yours. Provided the heating plant is reasonably well suited to the size, location and construction of the house, a little extra effort should enable you to 'force it' when the worst cold snaps descend. You can make certain of being able to do this and also steadily reduce your coal bills by the following methods, just as I have done:

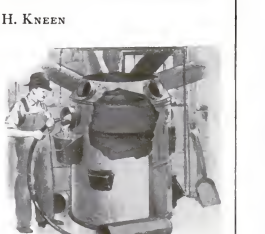
"See that the furnace is insulated to restrict radiation in the basement. Of the total heat units released from coal burned in your grate, only about a third may be reaching your rooms. Several years ago the U. S. Bureau of Mines found that the average of many tests showed only one quarter effective for actual heating. The engineers found that half of the lost heat units passed with the waste gases up the chimney, while the remainder were distributed among uncovered piping, poor firing and dirty flues. While a certain amount of lost heat in the basement helps to keep the first floor warm, anything more is dead loss.

"If your furnace is not clean, it may not be giving you half the heat that it should. The losses from accumulation of soot and ash dust are so great that it will well repay you to clean the furnace thoroughly.

"At intervals of about two months, in the heating season, let the fire go out and clean the radiator of a warm air plant (the top section around which the smoke passes to flue). A method that usually is satisfactory is to remove the stovepipe, insert a garden hose with nozzle set to throw a fine spray, and sluice the dust out, catching it with a pail as the dirty water pours out of the flue opening. Push the hose inside and around the radiator on each side. This will remove the dust and soot. It can be done in half an hour. Also clean the soot from the stovepipe by pushing a gunny sack tied to a stick through the sections.

"IN THE summer every part of the fire box, radiator and flues should be thoroughly scraped. Stiff wire brushes are used to remove the soot and dust from inside surfaces. Clean the warm air piping with the vacuum cleaner. Considerable dirt settles along the bottom of these pipes after a few months, which the first hot fire will stir up."

Parenthetically, the writer has found that much of the dust nuisance can be saved by sprinkling the basement floor regularly, and even the walls and ceiling, with the hose and a fine spray. It is convenient to keep a short piece of hose connected to a tap near the furnace for laying the dust before removing ashes.



Spraying the interior of the radiator of a warm air furnace to wash out soot and dust

A slight wetting of the coal also helps to lay the dust, but do not forget that every pound of water in the coal must be evaporated before the coal will burn, and the efficiency of combustion is reduced by that much. An old vacuum cleaner is useful for cleaning the basement. In cities an old cleaner often can be purchased for from five to fifteen dollars.

"HOT air furnaces sometimes reach their limit in very cold weather," the heating expert continued, "and if the whole house is being heated, no room will be really warm enough. By cutting off some bedrooms and unused rooms during the mornings, more heat can be thrown into the main living rooms. In the afternoons or toward the end of the evening, the fire can be well stirred up, part of the living room cut off, say half an hour before retiring, and the heat forced into the bedrooms. During the day, if the living rooms become overheated, they can be quickly cooled by opening the bedroom registers. As a rule, it is better to operate the dampers located near the furnace, thus saving the heat which radiates from pipes not in use."

"Many localities," said another combustion engineer of my acquaintance, "have soft coal from local mines, which can be burned satisfactorily. Buy the steam coal with the highest heat units per pound, but with the lowest ash and moisture content. Of the three, the ash percentage is of least importance, up to twelve percent. Keep the steam coal, which is rather fine, entirely separate from the egg-size lump coal used for starting fires. There is no object in burning coal larger than egg-size coal at any time; lump coal costs decidedly more and simply delays your fire until it has broken down into a burnable size. A ton of starting coal should be enough for three or four tons of steam coal; it need not be used except in the morning or when the fire is low.

"Thin layers (*Continued on page 95*)

The Shipshape Home

More Heat from Your Furnace

(Continued from page 94)

of steam coal can be added to the fire from time to time. Heavy charges of coal will dampen the fire and distill gases, which go up the chimney before igniting. Occasionally it is necessary to break up the coked surface, where it has arched over and burned out underneath. A good draft is necessary to 'coke' a soft coal into a solid bed.

"COAL-GAS explosions are common in winter, but quite avoidable. They come from a distillation of the coal with insufficient air, often caused by a layer of ash having accumulated on the grate bars. This gas finally ignites and explodes. A good shaking until hot coals start to drop into the ash pit will open up the fire and admit the proper amount of air for combustion. Too much shaking, however, will ruin a good fire. Efficient combustion will be aided by leaving the lower drafts almost closed, after a good bed of coals has been obtained. The explosions are usually not serious, but they often fill the house with gas and smoke, and also tend to loosen up the cement in cast-iron furnaces."

A cold winter, with many red-hot fires, will usually cause the cement between joints of cast-iron furnaces to crack and break, thus allowing smoke and gases, as well as ash dust, to seep into the warm air and up into the house. To be on the safe side, it is desirable to have the furnace taken down and thoroughly cemented every alternate season. Many houses are damaged every winter because this was overlooked during the summer months. You can detect gases by smelling the warm air arising from the register.

MOST chimneys are high enough to insure good combustion. If, however, you are in a low, flat building and find it difficult to get a strong draft, the chimney may be too low.

An average home burns from seventy-five to two hundred dollars worth of coal a season, depending upon the climate and other factors. Unless properly installed, the heating system probably wastes from twenty-five to one hundred dollars worth of fuel a season. This would pay for the services of a competent heating engineer the first season and be a "pure velvet" saving for every season thereafter.

Although there are modern improvements in home heating, such as automatic oil burners, a good many of us will continue to burn coal for a long time to come, and the more we apply ourselves to the improvement of our heating systems, the better it will be for our pocketbook.

HOME workers can keep their hands in good condition even when doing painting or particularly dirty work by rubbing a stiff lather into the skin and under the finger nails and allowing it to dry before they start work. The soap prevents the paint or dirt becoming ingrained in the pores of the skin.

Speeding Up Your Lathe Work

(*Continued from page 84*)

support, it will quickly break down if it has hard work to do. The second tool will last much longer, with a consequent saving of time, but it can be produced only on a straight face or with a special tool grinding machine that passes the tool across the curved surface of the wheel with a reciprocating vertical motion. It is practical, when grinding a tool, to rough it down on the face of the wheel, but the clearance should be afterwards straightened out on the side of the wheel if the grinding is done by hand.

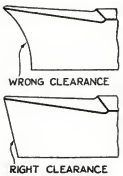


Fig. 3. The clearance should be straight

All work to be done on centers should be accurately centered. Where there is a centering machine in the shop, it is almost always a saving of time to use it.

After the centering is completed, the first operation on the lathe is to face off the work. On short shafts or cylindrical work a half center may be used to advantage for the facing operation.

Often jobs in small lots are repeated at intervals. In shops where it is not the practice to make expensive special tools and gages, the lathe man may take it upon himself, or ask the permission of the foreman, to make a cheap gage or template to increase the speed of production.

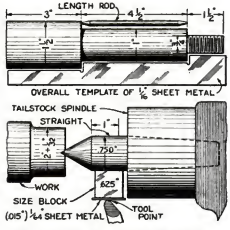


Fig. 4. A template for turning duplicate parts, and a quick method of setting a tool

If you have a small lot of, say, fifty or a hundred pieces that are to be turned to two or more diameters, as in Fig. 4, you can save time by turning all the pieces in the lot on the 1-in. diameter and follow up in the same way with the other diameters. If the pieces are to be finished to size in the lathe, all the roughing should be done first. Then follow the same procedure for the finishing and make a final set-up for the threaded end.

Fig. 5. Experienced lathe hands often make small size blocks for setting their calipers

Length rods and templates can be quickly made for the average job from scrap pieces of cold rolled steel and sheet metal. They can be used in checking boring and inside turning operations, as well as for shoulder measurements.

Small size blocks are useful for setting calipers (Fig. 5) or for gages when turning work having shoulders and two or more diameters. These may be made from standard sizes of cold rolled steel, although some machinists make hardened and ground blocks of tool steel. It is much quicker and easier to set a caliper with the blocks than by using a scale.

It is possible to use a size block instead of a caliper in gaging the diameter of work being turned. This is illustrated in Fig. 1. In order to make effective use of this method the tail center is made to some standard diameter, as .750 or 1.000 in. and on larger lathes in proportion. This diameter should run straight instead of tapering, as shown in Fig. 4.

Suppose you are turning 50 or 100 pieces of duplicate shafts that are to be finished on the grinder to 1¾ in. In the rough this diameter possibly will be from .015 to .020 in. larger. All you have to do is subtract the diameter of the tailstock center from the diameter of the work, divide this by two and use a size block to set the tool. A small piece of sheet metal will serve in combination with the block for the grinding allowance. If the job has more than one diameter, suitable blocks may be used for all. The point of the tool, which is presumed to be set on center, is then brought to bear against the block with just enough pressure to hold the block without slipping. Remove the block, start the feed, and your diameter will come right every time. No time will be lost in trying each piece with the caliper or "mike."

THIS method of gaging is, of course, recommended only on work where a few thousands one way or the other is not important, such as work that is to be ground and work that is to be left rough. It may be used to advantage, however, for all roughing cuts.

Cutting threads and cutting-off operations give the lathe man more trouble, perhaps, than any (*Continued on page 97*)

Speeding Up Lathe Work

(Continued from page 96)

man more trouble, perhaps, than any other work. Thread tools, to give the best results, should be made from the highest grade of steel obtainable and properly tempered. Hit or miss tempering will frequently cause trouble.

To get a smooth job in the shortest time on tough steel, use pure lard oil mixed with sulphur.

In threading cast iron, any tendency of the metal to crumble is often caused by insufficient tool clearance or a dull tool.

IF YOU are cutting a long thread, a great deal of time can be saved by throwing out the nut at the end of each cut and running the carriage back by hand. Many modern lathes are provided with a dial indicator that makes the trick of catching the thread simple and easy, but on old style lathes without this attachment, it can be done by chalk-marking the faceplate or chuck and the starting point of the carriage on the way of the lathe. Stop the lathe in the same relative positions of the marks each time and run the carriage back to the starting point.

When using a cut-off tool, run on open belt speeds whenever possible, except on very large diameters where the cutting speed would be too great.

With open-belt speeds there is less chance of the tool's breaking if it should stall the lathe; in most cases it will merely throw the belt off. Adjust the tool so that it cuts freely and do not force the feed. It is common practice to handfeed a cut-off tool, and unless the work is well supported the hand feeding method is the safer, as it is frequently necessary when making deep cuts to clear the slot of chips.

When turning shafts or other work having two or more diameters, you can save time by using two or more calipers.

When chucking a piece of work, the jaws should be set approximately to the rough position before placing the work. Measure the outside diameter and use the circles on the chuck face as guides in setting the jaws.

ROUGH-SURFACED or irregularly shaped castings are often difficult to hold securely in the chuck. All jaws should have a good bearing on the work and be as tight as it is possible to make them. It is advisable to chip a flat spot or knock off any bumps or high spots that might prevent the jaw from having a firm bearing on the work.

A true center line drawn on the faceplate will serve as a permanent aid in quickly transferring center lines on the work before it is removed from the lathe. When you have to place a center line on a job it is necessary only to set the point of a surface gage with the line on the faceplate, as shown in Fig. 2. This is a time-saving kink for tool and jig makers who must have accurate center lines on the work for subsequent operations.

When it is convenient and feasible, the tailstock center should be run against the work revolving in the chuck. This steadies the cut and allows maximum feeds and speeds to be used without danger of disturbing the setting.

A Pirate's Treasure Chest

(*Continued from page 77*)

The decorations may be of lead, copper, linoleum or even well-shellacked heavy pasteboard if glued in place before any shellac is applied. It is quite possible, indeed, to obtain the desired effect of an iron-bound chest by the use of gesso (whiting and liquid glue with a little varnish and boiled oil) or plastic paint. In any case, the presence of the antique nailheads is an important factor in carrying out the illusion.

In making the chest, cut the sides B, ¾ by 9½ by 24 in., and the ends E, ¾ by 12 by 14½ in. Note that B and E are ¼ in. wider than required, which allows for making the saw cut AA and fitting the joint. Cut off the corners of the ends E at 45 degrees as shown to receive the tops D. Plane the top edges of the sides B, setting a bevel by the angle of the sketch shown by the dotted line marked I-II between B and D of section A. Assemble B and E, using sixpenny finishing nails; drive them slantingly, being careful that they do not penetrate into the place where cut AA is to be made.

Plane the lower edges of B E so the bottom A, 16 by 24 in., will fit closely, and nail it in place. Bevel the edges of tops C D and glue and nail them in place, driving sixpenny finishing nails into the ends and 1½-in. No. 15 brads into the angular joints. Plane all surfaces flush and sandpaper with No. 1 sandpaper.

Make the saw cut AA and fit the upper and lower parts of the chest together. Fit 2½-in. iron or brass butts (hinges) with the entire rounded portion of their backs projecting beyond the wood of the chest. A suitable chest lock with an old-fashioned hollow key should be fitted. Select a lock in which the key is placed as low as possible.

Cut the ⅛ in. thick decorative strips, fit them to the chest itself as you proceed, and fasten them with antique upholstery nails. It must be remembered that the handle pieces M, which are ⅛ by 1¾ in. by 7¼ in., and N, ⅛ by 2¾ by 2½ in., have purely decorative functions and are not intended to be used in lifting the chest, as the material would not stand the strain involved. The handles should be fastened to the chest with nails or solder to prevent any one from trying to lift the filled chest by them. More substantial handles may be devised in a variety of ways, if the builder wishes to have them strong enough for actual use, but handles such as are commonly sold for chests should not be used unless they are treated to make them look thoroughly antique.

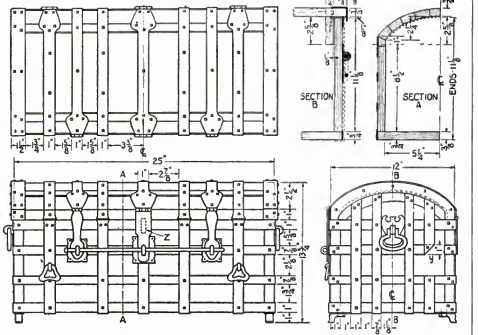


Fig. 2. How to construct a chest of more rugged design. Here, too, the ironwork may be either real or imitation, and a flat top may be substituted for the rounded lid illustrated

DRAW the scrolls, enlarging by the square method as indicated on Blueprint No. 78. Make patterns and place them upon the pieces from which the scrolls R S T U are to be cut so two may be made from each piece. Mark around the pattern carefully with pencil or scratch awl, and cut with knife, scroll saw or shears. If of soft metal, they may be placed together in pairs and sawed on a band saw. Smooth the edges with files or emery cloth to correct inaccuracies and remove burrs. Place the scrolls in their exact location, bend them where they pass around angles, and fasten with antique nails. Hold the feet in place with screws, or use plate casters.

The decorations may be fitted and fastened temporarily upon the chest, then removed, and the chest itself stained, filled and finished as desired. Then the straps and scrolls may be replaced and

(*Continued on page 99*)

A Pirate's Chest

(Continued from page 98)

fastened permanently. However, most workers will find it easier to place the decorations permanently in the first place and then finish the entire chest.

If the worker prefers to make a flat top chest, he should have no difficulty in adapting the above suggestions to the simpler form. Drawings of such a chest appear on Blueprint No. 78. The scrolls R will be the same in shape in both cases, only bent differently when they are fastened on. The length dimensions of S and T may be easily adapted. At Z extend the hasp back onto the top, say about 9 in., adapting either scroll R S or T as preferred.

FINISH the wood with dark oak stain followed by dark paste wood filler, which must be well rubbed off across the grain as soon as it becomes flat in color and appears to be drying. When the filler is hard, apply two or three coats of shellac, rubbing each with No. 4/0 sandpaper, and finish with wax. If preferred, two coats of brushing lacquer may be used over a single coat of thin shellac.

The decorations may be treated with aluminum, copper, bronze or other metallic paint, if their natural color when finished like the wood does not assist the illusion the chest is intended to create. A judicious use of burnt umber ground in japan or oil will aid the antique effect; apply the brown pigment freely and rub most of it off before it has had a chance to dry hard. A little powdered rottenstone dusted here and there before the finish is thoroughly dry will lend further antiquity to the appearance.

A more rugged type of chest is illustrated in Fig. 2, page 98. It should be a most attractive project for any home worker who likes iron as a medium of expression. But if he prefers, the worker may make the straps and trimmings of sheet lead or copper; indeed, straps of linoleum or gesso will carry out the illusion of extreme strength and suggest the dark deeds of Henry Morgan quite acceptably. The entire design may be simplified by making the top of the chest flat, for the dimensions and suggestions may be easily adapted to almost any size or similar design of chest.

The stock required is as follows: 2 sides ¾ by 8½ (1¼ in. being allowed for fitting the lid after assembly) by 25 (Continued on page 100)

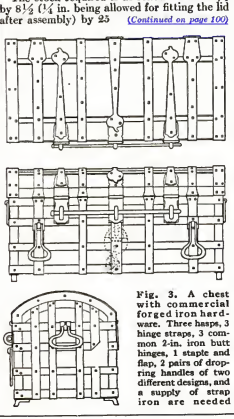


Fig. 3. A chest with commercial forged iron hardware. Three hasps, 3 hinge straps, 3 common 2-in. iron butt hinges, 1 staple and flap, 2 pairs of dropring handles of two different designs, and a supply of strap iron are needed

A Pirate's Treasure Chest

(*Continued from page 99*)

in.; 2 ends ¾ by 11½ by 10½ in.; 1 bottom ¾ by 12 by 25 in.; 2 false ends ¾ by 2⅝ by 10½ in.; 1 top ¾ by 15 by 25 in. to be split about 1¾ in. wide and beveled to make curved top; 2 edge pieces for top ¾ by 1 by 25 in.; straps, ⅛ by 1 in. by 50 lineal ft., ⅛ by ⅛ in. by 16 lineal ft. and ⅛ by 1½ by 30 in.; curved strips ⅛ by 12 by 12 in.; hasps and plates ⅛ by 2¼ by 42 in.; rods for handles, etc., ⅜ in. in diameter by 60 in.; 4 iron feet ⅝ by ⅝ by 3½ in.; 3 common iron hinges 8 in. long; nails, antique nails, screws and bolts.

CUT out the sides and ends. Curve the tops of the ends as indicated and nail the four pieces together with sixpenny finishing nails. The bottom may be of pine, nailed to the lower edges of the sides and ends. The two false ends should be shaped like the tops of the ends and fastened temporarily to a board in their correct permanent relation to each other. Note that they set back 1½ in. from each end of the top as in section B. Fit the edge pieces of the top, which are ¾ by 1 by 25 in., and nail them in place. Split the top piece into strips about 1¾ in. wide; these should be beveled, fitted, glued and nailed in position as indicated in sections A and B. Plane the top to a smooth surface of the desired curve.

If a flat top chest is being made, the last process is omitted and a piece of oak the same size as the bottom is nailed in place.

Smooth and sandpaper the entire outside of the chest and hang the cover with three 2-in. common iron butts (hinges).

We will assume that the chest is to be decorated with iron straps and trimmings, and that the worker has access to a small forge and the necessary tools and has some knowledge of their use. The exact length of the straps should be found from the chest itself rather than taken from the sketch. They may be held in place with small brads for fitting other pieces and for making holes that will coincide when the same bolts and nails are to be placed permanently. The brads may then be drawn or set out of sight.

WHENEVER possible, however, the permanent fastenings should be used at the outset; for example, fit the corner pieces, then the lengthwise straps, most of which may be fastened at once, for the vertical straps lay upon them. The splayed vertical straps at the joint of the chest and the spade shaped ends of the hinge straps may be heated and drawn to the desired shape.

The iron rod passing through the three hasps adds much to the impression of massive strength given by the ensemble. Fit the long top straps and the curved top ends, which should be flush with the tops of the top straps. These curves may be cut from a 12 by 12 in. piece, also the curved strip at the top of each end. Fasten these in place and fit and fasten permanently the top straps, hinge and hasp pieces and the vertical straps of the end.

Note that the curved end of the top shuts over the end pieces of the chest as in section B. The curious spacing and bending of the 1-in. straps at *y* should be carried out, also the somewhat erratic spacing of the straps, for this is characteristic of the work of that period and adds greatly to the quaintness.

The back straps may be omitted if desired, for they are usually out of sight. If an extra staple is placed at *z* and the hasp fitted over it, an awe-inspiring padlock may be used.

The end and side handles and the feet may be forged to their curious shapes and permanently secured.

Many home workers may wish to make the chest, but having neither tools nor smithing skill, find the cost of special forgings prohibitive. They may still make the chest, for stock forgings which acceptably reproduce the designs of old-time craftsmen may now be obtained through any hardware dealer, even if he does not carry them regularly on his shelves. They may be obtained in a variety of finishes, but for the sake of uniformity, it is well to give all the ironwork of the chest a coat of flat black paint. The high lights are then brought out by the use of emery cloth or steel wool, and a protective coat of shellac or varnish is applied, if desired. This will give a pleasing illusion of old age.

THE design shown in Fig. 3 suggests a chest similar to the one described, but planned to meet the needs of those who wish to use stock forgings. While the sketch suggests a method for the adaptation of these forgings to a chest of the same size, if the chest were 4 in. wider the strap forgings would fit as well or better; in fact, the chest may be made of any size by adapting form and measurements to conform to one's needs. In any case, some of the stock forgings must be cut to fit. The terminal design on the straps is known as the "curley lock."

There are certain advantages in finishing the chest, all but the final coats, before the irons are fitted; on the other hand, there is the danger of defacing the finish while placing the ironwork. Probably the best results will be obtained in most cases by staining, filling and finishing the wood after the ironwork is in place.

If desired, the chest may be built of pine and finished with paint or two or three coats of opaque brushing lacquer of selected colors.

Painting the Set

(*Continued from page 80*)

making of the frames, one by one, and the setting up of two or three adjoining frames. In that case the painting will have to be done a section or two at a time. Care must be taken to have the painting and particularly the spattering of the adjoining edges as nearly alike as possible. Otherwise, when the setting is set up as a whole, the difference in the finish will be very noticeable.

The painting of an exterior set, or the backdrop or window view of an interior set, calls for a little more artistic skill. If your group of players boasts an artist, the matter of painting a backdrop will rest entirely upon his ability to work on a considerably larger scale than he does for his usual easel pictures. He need only accustom himself to the use of tempera colors in order to work efficiently. But in this article I am addressing myself to the amateur scene painter, a man with good intentions but slight ability at drawing or painting. He will have to borrow from any and all sources available for his inspiration—magazine illustrations, snapshots, post cards, and advertising pages will offer him suggestions.

HAVING chosen a picture that will fit the play's requirements, he is confronted with the rather heroic task of enlarging this picture of only a few square inches to one that is measured in square feet. The simplest way to effect this enlargement is by the old reliable method of "squaring off." It consists merely of drawing over the surface of the picture that is to be enlarged a number of small squares. The backdrop is then marked off in corresponding proportionate squares. In this way the scene painter can draw in a square at a time, setting down merely the essential outlines.

The inexperienced painter should facilitate his task by a

(*Continued on page 102*)

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Scenecraft—Painting the Set

(*Continued from page 100*)

deliberate simplification of outlines. Instead of attempting to draw the more or less intricate details of his small picture, he will do well merely to suggest the simple masses, and handle his picture in a posterlike manner. The billboards on any American highway (alas!) will offer him suggestions not alone in the use of effective color but particularly in the use of simplified drawing and massing, boldly presented.

IT IS far better to attack the problem of painting the back drop with a dash and courageous flourish than to fail in a dismal effort to be realistic. And in these days of bright colors and expressionism the amateur need have only a brave heart, a willing hand, and a courage a little beyond his convictions in order to get away with his job. The average audience, which has long since become accustomed to be pleasantly shocked, will accept the daring scene painter's offering, whereas it will spurn the half-hearted wish-wash of the uncourageous amateur. Go to it with a zip, and remember that the play, the actors and the lighting are all in your favor.

Water colors in powder form should be used for scene painting. These are now manufactured in convenient one-pound packages in a wide selection of bright colors. They need only to be mixed with water to be ready for use. However, it must be remembered that wet tempera paint is many shades darker than when it is dry; for that reason, in mixing the paints in order to obtain colors other than those already in prepared packages, it is best to mix the dry powders rather than the wet paint.

The brushes depend a great deal upon the scene painter's personal preference, his experience in handling brushes, and the nature of the painting. For skies and flat surfaces a brush six or eight inches wide is best. For the indication of foliage, the painting of door and window frames and other narrower bands, a two-inch brush is convenient. The scene painter should also have a few wide bristle brushes of the long-handled kind used by artists. These are admirable for drawing in the outline of the back drop and indicating the shadow forms.

SINCE scenic colors are generally of a lighter shade than oils, the amateur scene painter may have trouble in defining the forms of the objects he is painting and giving to the picture the necessary appearance of solidity. For that reason it is best, I find, to establish the drawing by the use of a firm outline and indicate the shadows, all in a medium shade of gray-blue. This having been done, it is an easy matter to fill in the design by means of "broken" color, that is, color applied in dabs and obvious brush strokes. In this way the painting will possess a vibrant quality, which at a distance is far more effective than if the colors had been evenly applied.

In closing I must again urge upon the beginner in scene painting the importance of jumping into his job with a brave heart, an active and willing brush, and an absolute faith in his ability to do a good deal better than he thinks he can do. The spirit of make-believe that is at the heart of all play-producing will help him put it over.

The fifth article in Mr. Smith's series on amateur stage carpentry and scene painting will appear in an early issue.

The True *Santa Maria*

(*Continued from page 92*)

wales, the cables leading from the cat-holes.

The flags are best made from thin white silk, and painted with artists' water colors, using a little gum with the water. Photographic stamp colors serve well. The flag at the fore is green on white, and represents the badge of the Band of Discoverers. At the main is the royal standard of Castile and Aragon in red and yellow; at the mizzen the escutcheon of their Catholic Monarchs with the eagle of St. John; and at the mizzen peak, the streamer of the Castile Armadas.

A line of thin white shellac around the edges of the flags will prevent their fraying when cut. The staffs can be of wood or wire; reed chair spline is the best because it bends when accidentally knocked.

OTHER gay touches may be shields hung on the pavisades. These are easiest made from thin wood. A flat staple in the back of each, representing the arm hold, serves to hang it on a pin driven into the pavisade guardrail. The shields should also be tied in position. The designs given are more or less arbitrary, supposedly the arms of Columbus' companions.

To the mainmast there should be hung a slightly larger shield painted with the arms of Castile and Aragon, perhaps centered with those of Leon. This is to be carried ashore when new lands are taken possession of. Similarly, a cross on a long staff may be placed by the mizzenmast, to be handy for the same purpose.

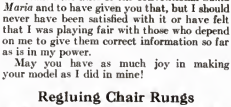
Everything is done now but the base on which to stand the model. Any kind may be used, but the simplest form is advisable. Mine is two pieces of ¾-in. oak, cut to fit on the bottom of the hull 6 in. apart, with the edges just curved out a little and joined with a square stick of the same wood, projecting through and fastened with wooden pegs.

There is your model! It will have taken longer to make than it has to read this, but I feel confident that everyone who has built it carefully will be more than satisfied.

It would have been so much easier for me to have taken the lines of the conventional *Santa Maria* and to have given you that, but I should never have been satisfied with it or have felt that I was playing fair with those who depend on me to give them correct information so far as is in my power.

May you have as much joy in making your model as I did in mine!

Regluing Chair Rungs

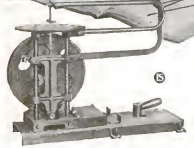


The dowels are inserted almost entirely in the rung and then worked partly into the legs

WHEN a chair rung breaks at the point where it joins the leg of a chair, it often can be repaired without taking the chair apart or using unsightly nails or screws.

Carefully saw off the rung at the unbroken end close to the leg of the chair and bore a hole in each end to receive a ⅜-in. dowel. Bore corresponding holes about ½ in. deep in the chair leg. Cut two dowels about ½ in. longer than the holes in the rung. Apply liquid glue and push them as far as they will go into the holes in the rung. Set the rung in place and with a knife blade work the dowels into the holes in the legs as far as possible. Bind the legs tightly with cord until the glue has hardened.

I'll loan you a SpeedWay Shop-just to prove you can make things like this!

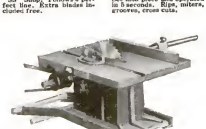


Handy Jig Saw

This Pattern Makers Jig Saw is part of the Model "SS" Shop. Follows a perfect line. Extra blades included free.

Practical Bench Saw

Built heavy and strong. Set into place and operated in 5 seconds. Rips, miters, grooves, cross cuts.



Get Your Magazine Basket Quick!

While they last, we are giving away the lumber to make the beautiful magazine basket shown down in the lower left hand corner. It is yours to keep even if you should decide to return the shop. Act at once before they are all gone. Instructions for making it are included of course.

Yours for the Asking

Everyone who fills in and mails the coupon will receive free of all charge, illustrated plans and instructions for making this beautiful Priscilla Sewing Cabinet. Perhaps you read about it in a recent issue of a well-known magazine but I want to show you how to make it in one fourth the time on my MOTORIZED work bench—the Speedway Shop!

Discard Your Hand Tools

Don't let hand tools put a limit on your Craftsmanship. Let me show you how to start with this simple Priscilla Cabinet—go on into grooving, mitering, mortising, scroll work, wood turning—make Humidors, Fancy Gateleg Tables, etc. Why limit your ingenuity when it is so easy to own a Speedway Shop? Remember—Speedway is the Shop used by Manual Training instructors everywhere.

Motorize Your Workbench

You can be sure you're getting the right shop when you realize that Speedway alone has been serving the World's Industries with Portable Electric Tools for the last twenty years. I want you to examine the exclusive features of a Speedway Shop.

ELECTRO MAGNETIC TOOL CO.

Department 5-F 1832 So. 52nd Ave., Cicero (Adjoining Chicago) Illinois

Trivial Down Payment

We'll show you how to earn or save the small down payments that come due just once a month. So simple too, for any man who knows his ABC's about tools. Ask what Mr. Watts of Miami, Fla. did. Send in coupon today!

Free Trial and Instructions—Free Plans and Materials

We are anxious that every owner of a Speedway Shop shall get the maximum pleasure and profit from it. That's why we have established the Speedway Personal Service Department.

24 Blue Prints Free

With each Shop we include 24 Blue Prints of Furniture, Toys, etc., that any one can make with the Speedway Shop. Mr. L. L. Hull in charge of our Personal Service Dept., will answer your special questions. Here is a real service department at your beck and call.

Free Crafts Books

When we receive your coupon we will send you a list of the best books on Craftsmanship from which to make your selection to be sent free with your shop.

Quick Action Needed

We cannot continue Special Offers like this indefinitely. Use the coupon today and we will send the Priscilla Cabinet plans and instructions at once! Mail today!

MAIL TODAY

Electro Magnetic Tool Co., Dept. 5-F 1832 So. 52nd Ave., Cicero, Ill.

Gentlemen: Please send me free the complete plans and instructions for making the Priscilla Sewing Cabinet shown above. Also complete details about your shop and free offers.

Name.....

Street.....

City.....State.....

My age is.....Occupation.....

I will use shop for fun ☐ for profit ☐

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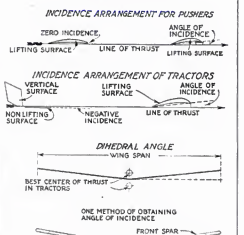
Model Airplane Design

(Continued from page 81)



How wings are set for best results on both pusher and tractor types of model airplanes

the "toothpick," or narrow. In tractors, where the diameter is not so restricted, the writers use the "toothpick"; for pushers, the wide-bladed type is used.

The propeller is a screw. Its advance into the air is determined by its pitch in the same manner as a nut advances on a bolt with each turn. As models have a relatively low speed, they should have low-pitched propellers.

The sizes of various parts of a model are best determined by a few general rules, but of course one may vary. It is well to know the aspect ratio; this is ratio of the width of the wing to its length, which may be from the proportion of 1 to 6 to 1 to 8. Plan tractors with a greater aspect ratio than pushers. Figure diameters of propellers at about one third the wing span and the overall length of the airplane about the same as its wing span. Design rudders with 1 sq. in. of surface for each 1 in. of propeller diameter. Allow for stabilizers with an area from 2½ to 2¾ times the rudder area. Make the forward wing on pushers with about one third the area of the main wing.

In the construction of single and two-stick fuselages for airplanes more than 24 in. long, it is best to use longerons which taper from the point of greatest strain—the point at which the rear undercarriage struts are attached to the front and rear.

Longerons in single-stick fuselages for the ordinary experimental models 24 in. long can be about ⅜ by ½ in.; for models from 36 in. to 40 in. long, ½ by ⅝ in., tapered. In two-stick fuselages, 24 in., use longerons about ½ by ⅝ in.; if 36 in. to 40 in., use longerons about ⅝ by ⅛ in. scant, tapered. Compression struts, skids and ribs should be about ⅛ in. square bamboo. Bamboo can be cut thinner for lighter weight airplanes.

UNDERCARRIAGES for small, lightweight models can be made of ⅛ in. diameter rattan. Lightweight 36 to 48 in. airplanes require ⅛ in. diameter rattan; heavy airplanes from 60 to 72 in. need ¼-in. rattan. For very small, single-surface wings, ⅛ by ⅛ in. spars are ample; for 24 to 30 in. wings, ⅛ by ⅜ in. Always round corners off with sandpaper. Double-surface wings should have ⅛ by ⅛ in. spars up to 30 in., with ⅛ by ⅜ in. leading and trailing edges; ⅛ by ⅜ to ¼ in., spars up to 48 in., with ⅛ by ⅝ in. leading and trailing edges. Wings of 72 in. require spars a scant ⅛ by ⅝ in. with ⅛ by ⅞ in. leading and trailing edges.

Longerons for built-up truss fuselages can be ⅛ in. square for airplanes of 36 inches, ⅛ in. square for 40 to 54 (Continued on page 106)

Build A Ship Model

Can Be Put Together by a School Boy in a Few Hours

$6.98 CONSTITUTION
Size: 26" high; 27" long; 8½" wide.

15-Year-Old School Boy Wins First Prize

$12.50 LA PINTA
Ship Model Loudspeaker
Size: 26" high; 27" long; 12" wide.

A HISTORICAL ship model should be in every home. We supply all the parts, cut to fit, and ready to put together. Every part necessary to construct any of the models pictured. A full diagram of numbered parts comes with every kit, with full detailed instructions so that it is impossible to make a mistake. All you need is a small hammer to tap parts in place. Here is a part of the instructions copied from the regular sheet that comes with every kit: Take part #57, place it at the front end of #56 and down on #55. Next take part #58 and place it at the rear end of #56 and tap in place with a small hammer.

So clear are the instructions that the 15-year-old boy pictured above won First Prize in a model contest held by the publishers of Science & Invention Magazine. Hundreds of ship models were entered from all parts of the country. This model was constructed from a regular kit of our parts. The educational and historical value a boy gains in constructing one of these models can not be measured in dollars and cents. Boys like to build things. They learn while they build.

These models, with the exception of the Constitution, may be converted into a beautiful toned loudspeaker that serves a double purpose, being useful as well as beautiful. The mainsail acts as the diaphragm and is driven by a unit of the electromagnet type. This attached to the mainmast, which is embedded in the hull. Power amplification is not needed as the unit will operate a 7½" cone. This assures you faithful reproduction at all frequencies.

$4.98 MAYFLOWER
Size: 25" high; 10" wide; 26" long.

$4.98 SANTA MARIA
Size: 25" high; 11" wide; 27" long.

SOLD ON MONEY BACK GUARANTEE
All goods shipped same day order is received

These Ship Model kits are not only for boys, but make a beautiful gift for everyone. Doctors, Lawyers, Business Men, Nurses, Stenographers and Housewives all over the country have built models from our complete kit of parts. They have become so interested in building the first model that, in many cases, they have sent for the parts to construct all our models. Ship Model building is indeed a fascinating pastime.

When the Model is completed it makes one of the finest home decorations that money can buy and the adventure of building your own models adds zest to the achievement. You will be proud of your model, because you are the builder.

MINIATURE SHIP MODELS, Inc.
3818-20-22-24 Baring St., Philadelphia, Pa.
Canadian Branch: **1485 Bleury St., Montreal, Canada**
Canadian Prices Slightly Higher. Send all Canadian Orders to Canadian Office.

MINIATURE SHIP MODELS, Inc., DEPT. O-5,
3818-20-22-24 Baring St., Phila., Pa.

Please send me complete parts, cut to fit and ready to assemble for the Constitution, $6.98 ☐; Santa Maria, $4.98 ☐; La Pinta, $4.98 ☐; Mayflower, $4.98 ☐. Melody Ships: La Pinta, $12.50 ☐; Santa Maria, $12.50 ☐; Mayflower, $12.50 ☐. I will pay postman purchase price plus postage (a few cents).
Check which model you want shipped.
Catalog only ☐

PLEASE PRINT NAME AND ADDRESS PLAINLY

Name.....

Street or R. F. D.....

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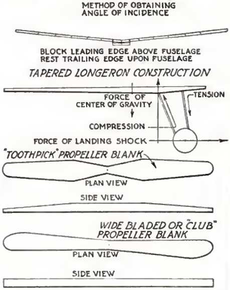
Model Airplane Design

(Continued from page 104)

in. models, and $\frac{3}{16}$ in. square for 72-in. models. Struts and diagonals, especially in the fore part of the fuselage, should be the same cross section as the longerons. To the rear the struts may be made lighter. Built-up fuselages should be covered with China silk, as its tensile strength makes it ideal for bracing the structure diagonally.

Select soft white pine for propellers. Make a paper pattern of the blade outline and draw around it to mark the block selected for the blank. One can have these blank outlines cut out at a planing mill on a band saw; this saves considerable work and time. The contour of the cross section should always be that of a wing curve. The blank for a 12-in. "toothpick" propeller of average pitch should be ¾ in. thick, and for a wide-blade propeller, ⅝ in. Center holes should be drilled accurately and the blades should be carefully finished with sandpaper and balanced. The concave side of the blades, after being cut down with a knife, can be scraped with a sharp piece of broken glass.

Ribs should be carefully matched in the bending process to assure an even curve throughout the wing panel. Always bend bamboo with the glossy side on the outside of the curve. The curving is easily accomplished. Hold the bamboo an inch above the tip of a candle flame and force it into the required



Where strains come when your "ship" lands—popular types of propeller blanks

curve. Then hold it in this position for a moment while it cools and it will retain its curve. White pine can be bent in the same manner, but it is best to soak it first at the point that is to be bent. Care must be exercised to prevent charring, especially with white pine. With a little practice, however, one can bend bamboo and white pine easily. Rattan is best bent in a form. Draw the outline on a board and around this outline drive brads. Soak the rattan well in water, then put it in the form. Dry it in an oven for a few moments but do not get it too hot, as that causes brittleness.

In the construction of wings put a drop of glue on the spar at the point where the rib is to be attached, then bind the rib in place with about five wraps of thread each way. On 4 to 6 ft. wings use seven or eight wraps of thread. In the construction of double-surface wings, the same wrapping holds both upper and lower ribs. After a wing is constructed, true it up and let the glue dry before covering.

To cover single-surface wings with bamboo paper, glue lightly (Continued on page 107)

Model Airplane Design

(Continued from page 106)

along the rib, spars and tips. After the glue is well dried, trim off the edges with a razor blade. It is not necessary to glue over the edges of the spars, as the glue on top will hold the covering securely and makes a neater job. In covering double-surface wings, glue along the ribs; leading edge, trailing edge and tips, but not the spars. Press on the covering and, when dry, trim off the margin and cover the other side in the same manner.

GIVE bamboo paper two coats of "dope," or bamboo varnish. Silk on the wings requires only one coat, but that on the fuselage two coats. In doping double-surface wings, coat the top side first and let it dry before treating the bottom. It is a good practice to give the framework of a model a coat of dope after the glue has dried thoroughly.

To cover wings and fuselages with silk, spread the silk over the framework and brush over with dope at points where the silk is to be fastened. The dope penetrates the silk and sticks to the framework. After the dope sets firmly along the ribs and spars, or longerons and struts, as the case may be, trim off the margin and dope the surface.

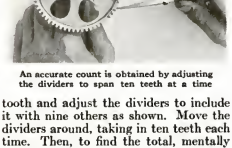
A model has the proper amount of power when the propeller stops turning before the plane lands. If it is still wound up when it lands, loop on a few more strands of rubber until the proper amount has been installed. A model can be wound until a double row of knots appears in the rubber.

In this article and one published in the December issue, the authors have described the most popular types of airplane models, listed the tools and materials for building them, and explained briefly a few general principles of design with which every model maker should be familiar. In their next article, they will tell in detail how to construct a single-stick tractor monoplane, one of the simplest and most satisfactory models for a beginner to build.

A Quick Way to Count Small Gear Teeth

COUNTING small teeth in a number of light gears is a trying job. Most of us have to count over several times before we get enough corresponding "finals" to satisfy us we are correct.

The illustration shows a quick and accurate way to count them. Mark one



An accurate count is obtained by adjusting the dividers to span ten teeth at a time

tooth and adjust the dividers to include it with nine others as shown. Move the dividers around, taking in ten teeth each time. Then, to find the total, mentally multiply the moves of the dividers by ten and make allowance for any teeth left over or under, as the case may be.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

ROSIN has many uses in the home workshop and should always be kept on hand. It serves as a noncorroding flux in soldering and is useful in making varnishes for second-rate work. Various knife and tool handle cements can be made with its aid. Other uses are in making cheap soaps and paper size, and as an adulterant of various waxes.

To make an alcohol varnish, powder or crush about ½ lb. rosin, add it to a pint or less of alcohol, and shake. Adding ½ oz. of alcohol soluble turpentine (ozonized or oxidized turpentine) improves the varnish.

A harder varnish is made as follows: Place the powdered rosin in a large metal or porcelain dish and set on a wide, shallow tray containing sand.

Rosin varnishes must be heated in a large vessel or else in a dish placed on a tray of sand to insure safety

For each ounce of rosin add 1/10 oz. of magnesium oxide, then heat to the melting point and stir for about five minutes until fumes are given off. Pour the molten mass on a metal slab to make a thin layer. This hardened rosin is then used in making a varnish as already described.

An amber colored linseed oil and turpentine varnish is prepared by heating 1 oz. of rosin and 1/10 oz. powdered calcium oxide in a very large vessel, as the mixture bubbles violently. Another way is to powder the rosin, mix it with the calcium oxide, and add linseed oil to the extent of about one half the weight of the rosin. Then heat as before, stirring continually. Cool on a sheet of metal or, if linseed oil has been used, merely remove from the sand bath, cool a little and add 1 oz. of turpentine for each ounce of rosin.

A knife and tool handle cement may be made by mixing 1 oz. powdered rosin, ½ oz. shredded beeswax and ¼ oz. plaster of Paris. This is placed in the hole in the handle and the tang of the blade or tool is heated and forced in place, melting the cement.

A wax for linen bowstrings is made of one part rosin and three parts beeswax.

The following label is intended to be pasted on the rosin container:

Rosin

Rosin melts at about 105 degrees C., slightly above the boiling point of water. It dissolves in alcohol, ether, benzol, benzine, acetone, linseed oil and turpentine. Alkalies saponify rosin.

Used as a noncorroding flux in soldering.

An alcohol varnish is prepared by dissolving as much rosin as desired in alcohol; a better varnish is obtained by adding a small quantity of alcohol soluble (ozonized or oxidized) turpentine.

Rosins may be hardened by being melted with various oxides such as calcium oxide (burned lime), magnesium oxide, and zinc oxide.

An Electric Set

(Continued from page 70)

line is 2⅝ inches above the baseboard. Then drill the holes for the volume control E2 and jack J. Fit the panel to the baseboard.

Now assemble the uprights to the base of one of the aluminum shields and set it in position at N2. It should be against the front panel. Rap the top of each upright with a block of wood, then remove the aluminum bottom plate and uprights and bore a hole deep enough and large enough in the baseboard where the impressions of the screws show to allow the aluminum bottom plate to lie flush against the wood. Next measure with extreme care the height of the center of the drum shaft above the aluminum bottom plate, and also measure the distance from the bottom of the groove in the upright straight back to the center of the drum shaft. Reproduce these measurements and center punch the location on one of the aluminum side plates. Drill through with a small drill and then go through again with a quarter-inch drill.

PUT the side plate in place and note whether the hole lines up with that in the coupling on the end of the drum shaft. If it does, clamp two more of the side plates to the one you have drilled, getting all the edges flush, and drill through with the quarter-inch drill. Enlarge two of the holes to half inch. These form the side plates to which the condensers are bolted by means of the single-hole mounting nut.

Go through the same procedure for N3, as locating the hole in the side plate of this shield separately will allow for any lack of squareness in setting the drum in the panel.

Next take all three of the cams supplied with the coils and file off as much of the end of the hub opposite the cam as you can without cutting into the set screw thread. Mount the cams on the ends of the condenser shafts. Assemble the coil mounting and carefully bend the plate that is screwed to the condenser frame so as to throw the coil over as far toward the condenser plates as possible and still have the cam clear the frame. You should be able to get the coils over far enough so that they will be three eighths of an inch from the sides of the aluminum shields, which is ample clearance.

Set the pins that engage with the cams so that when the plates are fully engaged the small coils will be just inside the end of the large coils. The pins and cams should be adjusted so that the small coils start to move out when the condenser plates start to disengage.

NEXT study Figs. 2, 3 and 4 very carefully and mark and drill the holes in the sides of the shields where the wires pass through, and also the holes for the screws that hold the instruments in place. You will be able to tell from the picture wiring diagram just where these holes should come.

Now get busy with the soldering iron and connect the upper ends of coils B1, B2, and B3 to the stationary plates of condensers C1, C2 and C3. Then connect the stationary plates of these condensers to the lower ends of the coils and solder on to one of the lugs on each set of stationary plates a piece of wire about nine inches long. These connections should be soldered in place before you start assembling the condensers with the coils mounted on them in the shields. They are the only connections that you cannot easily reach with the shields completely assembled except for the back plates and tops.

Now assemble the condensers in the shields. You will find that the half-inch hole is enough larger than the threaded portion on the condenser frame so that you can move the condenser enough to get the holes in line when you look through them from the ends. Put the long shaft through

(Continued on page 110)

An Electric Set

(*Continued from page 109*)

condensers C1 and C2 and into the coupling on the end of the drum shaft after cutting it off short enough so that the side plate of N1 can be slipped into place afterward. The regular shafts in these condensers are discarded. They slide right out by loosening the two set screws in the hub of the rotary plates. Don't forget to mount the two cams.

Next mount condenser C3 in shield N3. You will find that the regular shaft can be pulled out far enough to engage with the coupling so that no special shaft is needed at this point.

The rest of the assembly is merely a matter of fastening the rest of the parts in place as shown in the picture wiring diagram of Fig. 4 and in the illustrations in Figs. 2 and 3. Note that the fixed resistances E3 and E4 are bolted one with one end to shield N2 and the other with one end to shield N3.

TAKE particular care with this part of the circuit. E3 and E4 automatically apply the necessary C voltage to the radio and audio amplifier. Do not make any changes, however apparently insignificant, at this point.

Mounting the drum dial and condensers is the only part of the assembly that requires any particular care, and even this work will be found easy enough if you take the time to study out exactly what is required and don't do any drilling until you are sure that your measurements are right.

Wiring the Receiver

The wiring presents no particular difficulties. The parts are so arranged that the terminals, with the exceptions above noted, are easy to get at. Put in the wires according to the picture wiring diagram of Fig. 4 or use the theoretical diagram of Fig. 1 if you understand radio symbols. The theoretical diagram has been simplified to the last degree in order that those readers who are familiar with radio circuits will be able to grasp at a glance the essential differences between this full electric circuit and a similar battery operated receiver. Note that the detector shield N3 is grounded, which means minus B in this circuit. Shields N1 and N2 are connected together because of the common condenser shaft. Connecting points marked X in the diagram supplies the needed C bias.

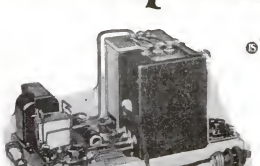
PUT in the wires inside the shields first, checking each connection as you go along so there won't be any mistakes to rectify afterwards. Be careful to get the wiring in shields N1 and N2 as nearly alike as practical, so that these stages of radio-frequency amplification will tune exactly alike.

Leave the back plates off until you have all the wiring inside the shield finished, then slide the back plates in place and stick the ends of the rear wires through the holes and solder them where they belong.

The filament wiring for sockets G1, G2, G3 and G5 is done by soldering the ends of two five-foot pieces of the No. 10 special wire to the F terminals of socket G5. Then the two wires are twisted together and brought along back of the shields where short pieces of regular flexible hook-up wire can be brought out from the F terminals of sockets G1, G2 and G3 and soldered to the heavy wires. The sockets are all connected in parallel, and as the current in this circuit is alternating, the plus and minus markings have no significance whatever. If you can't get the special No. 10 wire use six lengths of the regular wire, three to take the place of each No. 10 wire.

The filament circuit of socket G4 should be wired with a pair of regular wires for each filament terminal twisted together to form a cable. Carefully tag the ends of each pair so that you won't make (*Continued on page 111*)

How's Your Old Audio Amplifier

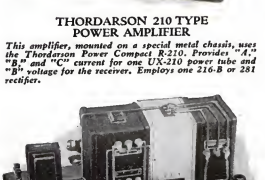


THORDARSON 171 TYPE POWER AMPLIFIER

Built around the Thordarson Power Compact R-171, this power amplifier supplies "A," "B," and "C" current for one UX-171 power tube and B-voltage for the receiver. Employs Raytheon B. H. rectifier.

THORDARSON 210 TYPE POWER AMPLIFIER

This amplifier, mounted on a special metal chassis, uses the Thordarson Power Compact R-210. Provides "A," "B" and "C" current for one UX-210 power tube and "B" voltage for the receiver. Employs one 216-B or 281 rectifier.



THORDARSON 210 PUSH-PULL POWER AMPLIFIER

This heavy duty power amplifier operates two 210 power tubes in push-pull and has an ample reserve of power for "B" supply for the heaviest drain receivers. Built with Thordarson Power Transformer T-2098, and Double Choke Unit T-2099.

A Home Assembled Thordarson Power Amplifier Will Make Your Receiver

A Real Musical Instrument

IMPROVEMENTS in the newer model receiving sets are all centered around the audio amplifier. There is no reason, however, why you cannot bring your present receiver up to 1928 standards of tone quality by building your own Thordarson Power Amplifier.

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An Electric Set

(*Continued from page 110*)

a mistake and cause a short circuit when you come to connect the cable to the terminals of the power unit later on. A twisted pair is also connected to this cable and run over to the small light that illuminates the dial. The 2½ volts will give a soft light behind the dial, which will be found ample for tuning; but if you want a very bright light you can use a three-volt two-candlepower auto bulb. This will not fit the socket provided, but it is easy to solder leads to the contacts on the bulb.

No binding posts are provided except for the antenna and ground. The wires conveying current to the set and the plate current that transfers the signal to the powerful amplifier incorporated in the high power supply unit to be described next month, or to the medium power unit to be described in the month following, are to be pulled through holes cut in the floor of the upper compartment of the console cabinet and connected to the binding posts on the power unit.

You will note in illustration in Fig. 3 that a single lead is brought out near the rear of the receiver and these leads are bunched together and brought out close to bypass condenser C11. The single lead is the P lead of Fig. 4 and the three leads in one bunch are the B minus, 45 plus and 90 plus. Do not bundle the P lead in with the others.

Then in Fig. 4, the picture wiring diagram, you will notice that the twisted wires to be connected to the 2½-volt alternating current supply are brought out at the back of the set in order to simplify the diagram. Actually you are to out at the left end of the set along with the 1½ volt leads as shown in Fig. 2.

Console type cabinets are made to accommodate sets with thirty-inch panels, so there is ample space at both ends of the set where you can bore holes through the floor of the upper compartment through which to pass the wires down to the power below. The terminals of both types of power unit will be arranged to match with the holes.

THE construction of the receiver is exactly the same no matter which type of power amplifier and current supply unit is chosen.

You will find that Blueprint No. 79 will prove a big help in building the receiver. It gives many details that space limitations will not allow us to include here.

In the next issue of POPULAR SCIENCE MONTHLY (March) you will find a constructional article showing you how to build the current supply and high power amplifier unit that forms, with the receiver described here, a complete electric radio receiver of the very highest class. The article also will give instructions on connecting the two sections of the electric set in the conventional type of console radio cabinet together with complete operating instructions. A blueprint of the high power unit will be available at that time.

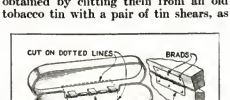
In the following issue of POPULAR SCIENCE MONTHLY (April) there will appear a constructional article showing a medium power amplifier combined with a current supply unit that will appeal to those of our readers who do not care to invest the amount necessary to build the ultra-powerful outfit.

But no matter which power unit you decide to build, you may proceed at once with the construction of the receiver portion of the complete outfit as described in this article. Both types of power units are designed to give exactly the right voltages to operate our new receiver without making any changes or adjustments in the receiver or in the amplifier unit. In fact, both types of power units are of the fixed voltage type with no adjustments of any kind.

If you do not care to buy a console type of cabinet, you can get a regular type of radio cabinet at least twelve inches deep and then mount the power unit on a shelf underneath.

Small Hinges Cut from Old Tobacco Tin

WHEN one has need of small hinges for a fancy box, they can be quickly obtained by cutting them from an old tobacco tin with a pair of tin shears, as

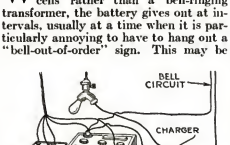


By cutting a section out of an old tobacco tin, a small hinge can be quickly made

shown. Attach the hinges with brads. This proved a useful expedient in one instance after an unsuccessful hunt had been made in the hardware stores of several towns for a very small pair of hinges.—W. H. TROWBRIDGE.

Radio Storage Battery Used for Ringing Doorbell

WHEN a doorbell is operated by dry cells rather than a bell-ringing transformer, the battery gives out at intervals, usually at a time when it is particularly annoying to have to hang out a "bell-out-of-order" sign. This may be



Without disturbing any existing wiring, the bell wires are connected to the battery

easily remedied in any household where a storage "A" battery is used for operating a radio set. All that is necessary is to disconnect the old dry cells and extend the bell wires that were connected to them as far as the terminals of the storage battery. A three-ampere plug fuse should be inserted in one line of the bell circuit as a safety precaution.—EDWIN J. BACHMAN.

Two Easily Made Holders for Cabinetmaker's Scrapers

WHEN large wooden surfaces have to be scraped, it is much less tiring to use a scraper with a handle than a plain steel blade. If one of the various types of commercial scraper holders is not available, a wooden handle can be made quickly in either of the ways illustrated.—HAROLD A. MELROSE.

The scrapers fit into slots in the handles

Nine Wonders of the Modern World

(Continued from page 13)

in 1856, was the Bessemer converter, embodying an economical process of decarbonizing cast iron. This, with the subsequent invention of the regenerative open hearth furnace and the development of the rolled I-beam, gave modern builders a cheap material twenty times as strong as wood, ten times as strong as stone, and five times as strong as cast iron. The famed hanging gardens of Babylon rising 400 feet may have been wonderful, indeed, yet they could not have compared with the marvelous towers of steel that now spring up on every hand.

CEMENT, likewise, has been used for centuries. The earliest was little more than mud. Builders of the Pyramids made mortar of burned gypsum, and the Romans learned to mix volcanic ashes with burned lime. But it remained for the invention of Portland cement in 1825 and the development of the rotary kiln nearly seventy years later to produce the artificial rock that can be molded into virtually any form and shape desired.

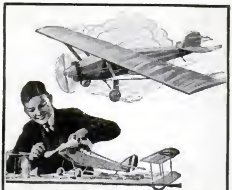
The wonder of metal construction goes hand in hand with Dr. Stratton's sixth wonder, that of "*modern metallurgy*." This fascinating science, by combinations of metals and by delicate processes of heat treatment, has created alloys possessing special qualities, such as strength, lightness, or toughness, to meet special needs. In steel alloys these properties are imparted by introducing quantities of such metals as tungsten, nickel, manganese, chromium and so on. The list of marvelous materials, already long, is continually growing. For example, nickel steel, fifty percent stronger than ordinary steel, is used for propeller shafts, engine forgings, automobile frames, and recently also for bridges. Manganese steel makes burglar-proof safes and rock crushers because of its remarkable hardness and toughness. Chrome and chrome nickel steels are used for armor plates and projectiles, plows and automobile forgings. Silicon steel, possessing unusual magnetic qualities, provides the core material for electric transformers and generators. Vanadium steel, one of the newest and most wonderful, possesses tensile strength of from 100,000 to 225,000 pounds to the square inch. Its enormous toughness and resistance to twists and jolts makes it especially valuable for automobile gears, axles, engine parts and springs.

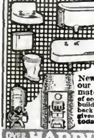
AMONG outstanding new metals is duralumin, the aluminum alloy of extremely light weight and strength, widely used in construction of airplanes and dirigibles. Metallurgy also has performed many works of magic in transforming the properties of metals. Such was the transformation of brittle tungsten into ductile wire suitable for filaments in electric lamps—a laboratory achievement which made possible the tungsten lamp.

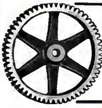
With the perfection of electric furnaces with temperatures as high as 6000 degrees F., metallurgy promises still greater things.

Not every person, perhaps, would think of including among today's wonders the seventh on Dr. Stratton's list—"*processes of food preservation, including canning and refrigeration.*" Yet, next to food itself, the preservation of foodstuffs is the vital factor in modern existence. It is the support on which modern industry rests; for it is the only thing that enables people to congregate in industrial centers, distant from the sources of food supply.

The inventor to whom we owe the discovery of food sterilization was a Frenchman named Nicholas Appert who, in 1795, learned how to preserve fruit by inclosing it, after heating, in a glass bottle which he (Continued on page 115)







Nine Wonders of the Modern World

(Continued from page 114)

then corked and immersed in boiling water, and let cool. Much the same principle is employed today in great canning plants.

The science of canning has progressed along with discoveries concerning bacteria and their chemical actions in fermenting and spoiling foods.

Nations now depend more on refrigeration, probably, than on any other method to provide a continuous supply of clean food. Since bacteria cannot grow and multiply at freezing temperatures, thousands of tons of perishable food are preserved and transported thousands of miles. Not the least of the new developments is electric refrigeration which is replacing the not always dependable ice man.

No tabulation of wonders, of course, could omit "*aircraft and aerial navigation.*" It is the hope of centuries fulfilled. Men always have dreamed of flight, but no age until the present has had a Lilienthal, Langley or Wright brothers to dare and conquer. In the twenty-four years since the Wrights showed the way in their first successful flights under motor power, the flying machine has girdled the globe, explored the Pole, spanned continents and oceans. With a speed of 300 miles an hour it has eclipsed all records for mechanical force, climbed to a ceiling of nearly eight miles, and flown for fifty hours without stop.

STILL, the highest goal of all remains to be attained; to prove itself safe and dependable under every condition. The invention of ingenious instruments of navigation, like the earth inductor compass, wind and drift indicators and radio beacons, are long steps toward this end.

Equally wonderful are the mighty dirigible liners of the air, the greatest of which soon will be launched in America and Europe. Beside any one of these, the 103-foot Colossus of Rhodes would appear as a brazen pigmy.

When Dr. Stratton named, as his ninth and last wonder, "*the development of machinery to lessen the burden of labor and to increase its output,*" he made it plain again that his selections were listed not at all in the order of importance. In the stretch of more than a century between the cotton gin of Eli Whitney and the latest automatic mathematical machine, a host of inventions have arisen to relieve the drudgery of both hand and head labor and enrich the world. The harvesting machinery of Cyrus McCormick, which revolutionized agriculture, the sewing machine of Elias Howe, typewriters, calculating machines, automatic lathes and milling machines, dictaphones, printing presses, linotype machines, automatic telephone exchanges—one might go on swelling the list almost indefinitely.

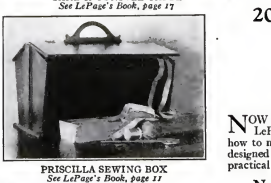
For what is perhaps the most valuable contribution of all—the standardization of parts and the division of labor in manufacture—the world is indebted to Eli Whitney. That sturdy pioneer in invention, braving ridicule, contributed to our age the process of mass production which remains the wonder of industry.

If a tenth wonder were to be added to the list, it might well be this:

Whereas the seven wonders of the ancients crumbled and decayed with time, the modern wonders of applied science are never ending. They grow and endure.

One of these days the dread specter of disease that stalks among us may be no more. Immunization, the modern wonder of medicine, holds out fresh hope that humanity may free itself from its burdens of sickness. A fascinating article, scheduled for the March POPULAR SCIENCE MONTHLY, tells how doctors believe this miracle may be accomplished.

CARD or CONSOLE TABLE
See LePage's Book, page 17



PRISCILLA SEWING BOX
See LePage's Book, page 11

DRESSING GLASS
See LePage's Book, page 21

PIANO BENCH
See LePage's Book, page 9

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20 Attractive Pieces of Furniture

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NOW in the long winter evenings, let this New LePage's Home Work Shop Book show you how to make 20 different pieces of gift furniture, designed by an expert—attractive, artistic, useful, practical and easy to make.

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What Doctors Don't Know About Diet

(Continued from page 24)

found to have no ill effects upon experimental animals, while an alkaline diet had definitely bad effects! Nor has acid diet been shown to cause kidney trouble, as certain faddists have asserted. The body can easily neutralize excess of acid or alkali of any normal diet. Thus, when acid foods are eaten, the normal system easily increases the amount of blood alkali in compensation. While a strictly acid diet is, of course, not to be advocated, the faddist here, as usual, has exaggerated the subject's importance.

Possibly millions of Americans have innocently followed the advice, "Do not eat proteins with starches!" This is absurd on the face of it when you consider how often Nature supplies this very combination in foods that digest well, like cereals or beans. Do we have to pry the protein from the starch before eating whole wheat bread? Milk itself contains a complex combination of starch and protein. Furthermore, when proteins are eaten with starches, the former unite with the stomach acid, tending to lower stomach acidity and so permitting the alkaline salivary digestion to proceed on the starch unimpeded.

A MIXTURE of starch and protein foods will leave the stomach more rapidly than protein alone, and the addition of the starch may actually speed digestion. Perfectly healthy people combine the two continually without harm.

Again, how often do we hear the warning, "Too much sugar."

We are told to substitute honey, raw sugar or maple sugar. Yet there is nothing harmful about granulated sugar in reasonable quantities, and few persons ever eat sugar to dangerous excess.

The fear that sugar will cause stomach fermentation appears unfounded, because the high acidity in the stomach doubtless makes fermentation impossible. Moreover, the body is well supplied with acids and the chemical accelerators called enzymes, which break down common sugar into the simpler sugars which the body can use. Even milk sugar has to be so broken down into dextrose. Cane sugar gives with dextrose an equal quantity of fruit sugar or levulose, which must somehow be changed over into dextrose before the body can use it. This alchemy of the organism cannot be reproduced in the laboratory as yet. Honey, of course, is already broken down, but its levulose must too be changed over to glucose or dextrose.

OTHERWISE honey has no especial virtue. Vitamins are present only in small amount. Maple sugar is simply the same compound chemically as is found in beet, cane or sorghum. Potassium, of which we always get plenty, predominates in honey and maple, while calcium, which we do need radically, is not plentiful.

When confronted with a case of indigestion, many a physician throws his stethoscope into high gear and says, "Now no fried stuff and no pastry for you. No pies, no French fried potatoes—and you better cut out bananas." Well, what about it?

Bananas are so far absolved that specialists are advising them as ideal food for very young infants. A standard medical journal of America editorially finds nothing gastrically reprehensible in a well-made fruit pie.

The fried potato has been found guiltless. The starch is more thoroughly cooked than in boiled potatoes and no normal human stomach should find fried potatoes indigestible unless they are literally varnished with fat.

For fat does in certain sensitive people interfere with the delicate mechanism controlling gastric motility. (Continued on page 117)

What Doctors Don't Know About Diet

(Continued from page 116)

A curious quack dictum is that "milk, starch, and fruit is an acid-forming combination." This is not necessarily true, for it would depend altogether on the proportions. Certain fruits could readily make the combination alkaline.

"Never eat more than one kind of starch at any meal," is another. In ordinary foods you are almost bound to eat starches from more than one source.

"The mixture of bread, butter, meat and potatoes is very harmful." If so, then milk too must be harmful, for it combines the same food materials—protein, fat, carbohydrates (starch and sugar) and mineral matter.

"Don't eat eggs, because they make the blood a good culture medium, promoting infection," says another prominent physician. The truth is that the blood is normally an ideal culture medium for bacteria, and the proteins of eggs cannot pass directly into the blood stream as such.

In exposing food fallacies such as these, do not imagine that I am seeking to minimize the importance of proper diet. Scientific nutrition is vitally necessary and is too much neglected. Instead of reliable knowledge to guide us in healthful eating, we are overburdened and bewildered by all sorts of reckless quackery and unfounded theories. What we need most of all is closer coöperation between physicians and laboratory investigators to carry the latest scientific discoveries about diet to the public.

Experiments have demonstrated conclusively that the prevailing American diet today is deficient in health-building materials. They have shown, too, that even a slightly deficient diet, continued over a long period, is very insidious in its evils. Moreover, the effects of a bad diet are visited upon coming generations. It is well known, too, that such diseases as rickets, scurvy, and beri beri result from faulty nutrition.

IN GENERAL, we Americans eat too many over-refined cereals, too few green vegetables, and too much muscle meat to the exclusion of organs such as liver and kidney, rich in needed food substance.

The prevailing American diet, consisting of milled cereals, peas and beans, meat and deficient amounts of milk has proved inadequate in calcium, so vitally needed for bone building, and in vitamin A, which promotes growth. Such a diet will prevent even a rat from reaching full size or attaining normal fertility. At first glance, a typical menu of such good American food does not look so dangerous. It might consist of—broiled steak, mashed potatoes, buttered beets, combination salad (or gelatin, peas or carrots), bread, butter, sweet pickles, apple pie, coffee and cheese.

Yet, as we are told by a leading authority on nutrition, Dr. E. V. McCollum, "when a family is confined to such food supply throughout several generations, the physical development gradually deteriorates. They show signs of old age rather early and fail to maintain a well-nourished appearance." But add fat soluble vitamin A and calcium, and the picture changes completely. Since milk is the most accessible source of calcium, this means we need to raise our milk consumption to a quart a day to a person, and increase our consumption of all the following foods—butter, cheese, creamed soups, spinach, turnips, beet tops, celery leaves, romaine, collards, lettuce, cabbage, cauliflower and endives.

In short, if you will drink plenty of milk and eat freely of raw or lightly cooked green vegetables and raw fruits to round out the ordinary basic diet, you will fulfill the fundamental requirements of well balanced nutrition. You can forget about "going on a diet" and be joyful.

Exit—the Torch Burglar

(*Continued from page 31*)

which, though small, cooked a four-course dinner thoroughly. The secret was revealed. She used only copper pans and kettles. Copper was a ductile metal, a great conductor, and it was because it absorbed all the heat from the smoldering log and diffused it to all parts of the pans that the peasant housewife got results.

The metallurgist at once conceived the idea of using copper in bank vaults. Hitherto the use of manganese and chrome steel had predominated, for it offered the strongest known resistance to the torch. But it concentrated the heat on one spot and that, he believed, explained why it was vulnerable. Copper would diffuse the heat.

A month later, in a Pennsylvania laboratory, the metallurgist stood before a committee of doubting bankers and safe builders. Steel, they told him, was the nearest thing to an attack-proof metal. Copper was soft metal, they said; it melted easily and a torch would go through it like a hot fork through butter.

"ALL right," said the metallurgist, "if you men can stand the glare of a torch we'll see what happens with steel, iron and copper."

The bankers agreed to watch.

A plate of steel one inch thick and a foot square was stood on end against a wall of fire brick. An oxy-acetylene torch under 120 pounds oxygen and twenty pounds acetylene pressure burned a hole through in two seconds! A plate of five-ply steel, one inch thick, was pierced in the same time.

A plate of cast iron two inches thick was burned through in seventeen seconds, using a three-eighths-inch fluxing rod.

"Now we'll use cast iron mixed with a small portion of copper," the metallurgist announced, and his assistants racked a two-inch plate against the fire wall. A fluxing rod was again used and a hole burned through in twenty-one seconds.

Next the section of a circular vault door was rolled in. This section, sixteen inches thick, was made up of a 6-inch layer of steel, an eight-inch layer of cast iron and copper, and a two-inch layer of five-ply chrome steel. The size of the hose leading from tank to torch was increased to a half inch. In twenty-four seconds a one and one half inch hole was burned through. Twenty pounds of gas was consumed.

"Now we'll try pure copper," the metallurgist announced.

A SEVEN-INCH-THICK plate of commercial copper stood upon the rack. The torch was applied. In less than a second its tip dissolved under the intense heat! Two seconds later another tip melted; then the supply of gas was exhausted and two new lengths of pipe were used to replace those which had burst. At the end of fifteen minutes, actual burning time, the torch was shut off. The flame had eaten in only seven eighths of an inch!

"At the rate we have been burning" the metallurgist explained, "120 minutes would be required to penetrate the copper plate. This means 211 times the resistance of the cast iron-copper plate we tried before. When you prolong the torch operation two hours you have beaten the bank burglar."

One final test was made with a new secretly compounded vault copper specially treated for drill and torch resistance. Against this a torch burned for ten minutes, but had no effect on the plate.

Since then 400 of the largest banks in the country have installed vaults made of the new copper shield. Burglars have attacked several of them but, in each instance, have abandoned their attempt.

After all, the lowly copper, which most bankers detest, has proved one of the best friends he's ever found.

Make More Money

Read the Money Making Opportunities on pages 136 to 166 of this issue.

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Is Telepathy All Bunk?

(Continued from page 33)

the collected experiences of eminent persons are flaws that cast doubt on the evidence. And, as Dr. Estabrooks says, "People don't always misrepresent the facts consciously, but they fail to perceive the details accurately and thereafter they unconsciously exaggerate a little point here, and another there, until the final story goes off at a tangent quite distant from the actual facts."

So science dismisses the ponderous mass of collected cases of telepathy with a shrug and an, "Interesting if true."

As for the demonstrations of professional mind readers, these are almost universally admitted to be fraudulent. The majority of the professionals do not even claim their results are more than clever trickery.

DR. RICHET and Warcollier mention that Thomas A. Edison was led to believe in mind reading, some ten years ago, by the exploits of a professional mind reader, Burt Reese. Now Dr. Walter Franklin Prince, a brilliant and relentless investigator, has revealed that Reese's method was mere sleight of hand. If Thomas A. Edison was deceived—and if men of the standing of Richet and Warcollier nevertheless offer his alleged conversion as evidence—we can see why the psychologist discredits both the exploits of professional mind readers and the testimony of eminent men.

Dr. Coover says that if telepathy can ever be proved, it must be in the psychologist's laboratory, where all conditions can be controlled and minute observation can be applied and properly recorded at the time.

Before we come to the laboratory experiments, however, one famous case of drawing room telepathy remains.

It concerns Professor Gilbert Murray, world-famous scholar of Oxford, who in 236 experiments between April, 1916, and April, 1924, has had thirty-six percent of complete success in either guessing or receiving mental pictures from a group of friends. Murray leaves the room, those who remain decide upon an idea, and when the professor returns they concentrate mentally upon it and he attempts to "read" it. Often the thought is a scene from literature or history.

I asked Dr. Estabrooks how the psychologist explains Professor Murray's extraordinary results.

"PROFESSOR MURRAY himself suspects the possibility of some sort of hyperaesthesia," said Dr. Estabrooks. "Remember that he is one of the best read men in the world. And in his unconscious mind there is probably ten times as great a store of literary and historical knowledge as in his conscious mind. So it is quite possible that faint but perfectly normal cues from other members of his group may stir up the appropriate picture in his own mind."

Modern psychology teaches that there can be no thoughts without muscular movements that tend to form words. The possibility that Professor Murray detects and interprets such movements is important. Professor Joseph Jastrow, psychologist of the University of Wisconsin, has shown by records with delicate apparatus that a man thinking himself absolutely motionless while concentrating upon an object, actually makes constant minute movements with his hand that point toward the object or outline roughly its shape.

It is plain, then, why alleged personal experiences of telepathy, together with compiled cases and the work of professional mind readers, are unacceptable to science.

The laboratory tests alone remain. There have been four notable ones in this country. Three have shown only negative results. In the most comprehensive of all, those by Dr. Coover at Leland (Continued on page 120)

Is Telepathy All Bunk?

(Continued from page 119)

Stanford, two hundred students were put through ten thousand tests in which the experimenter drew a card and sometimes looked at it and attempted to transmit the idea of it to the subject. Out of 5135 cases in which the experimenter actually looked at the card and endeavored to transmit its name there were 153 complete successes.

The successes were so close to the number of correct guesses to be expected from the theory of probability (128) that Dr. Coover decided nothing but chance had operated. Furthermore, in 4865 cases the experimenter did not look at the card and made no effort to transmit it. The results of this series of tests confirmed the results of the other. And finally, in a series of a thousand tests with ten students who seemed to have special psychic powers, there was no better showing for telepathy than the larger group of students had achieved.

Dr. Coover's negative results were paralleled by Dr. L. T. Troland, at Harvard, who also used playing cards with no greater success.

Then Dr. Murphy took up the subject and he says:

"The great bulk of my work has yielded results closely comparable to those of Dr. Coover; that is, the vast majority of successes offer no difficulties of explanation in terms of coincidence."

The fourth set of laboratory experiments was carried out by Dr. Estabrooks, who succeeded Dr. Murphy in the Psychical Research Fellowship at Harvard. He picked his subjects at random from among friends and students. He directed them to sit at a table in one room, and name a card every time an automatic time signal clicked. In another room, separated from the first by a closed double door, he cut cards and visualized one intently at each time signal.

EIGHTY-THREE subjects named the color correctly 938 times; if their guesses were determined by chance alone they should have named it correctly only 830 times. They named the suit correctly 473 times, chance of correct guess being 415 times.

Carefully analyzing his results in several different ways Dr. Estabrooks concluded that the figures simply could not be explained merely by coincidence. And that there seemed to be some unknown human faculty underlying the correct namings was implied by one odd circumstance. The students, in naming the first ten cards "transmitted," were uniformly more successful than the second ten. If they named only by chance, there should have been no element of fatigue. If there was some human power involved, fatigue would be explained.

Furthermore, in one series of tests, a moment of rest was allowed between the naming of the first and second tens. The second ten were named more successfully than in other series which were run off without a rest period.

But even in Dr. Estabrooks' experiments there are circumstances that leave room for doubt.

For instance, the twenty-eight subjects tested in his first series of experiments were tested a second time, with the "sender" now in a room sixty feet distant. There were four closed doors between him and the "recipients." The results were wholly negative. Success was slightly below the likelihood of chance, both in naming color and suit.

If you interpret these experiments as proving that telepathy exists but that the transmitting power is so weak as to fail when the distance is increased a few feet and four instead of two doors are interposed, then you will find it hard to explain the apparent success of telepathy in experiments by Dr. Murphy and Warcollier when the distance was anywhere from two to thirty-six hundred miles.

And there is on record a brief set of experiments by Professor (Continued on page 121)

Is Telepathy Bunk?

(Continued from page 120)

H. J. F. Brugmans, of Groningen University, Holland, in which the successes outnumbered the failures considerably more than chance would seem to account for.

Nevertheless, the negative results in three elaborate experiments seem to counterbalance the unexplained phenomena of the other two. Indeed, as Professor W. B. Pillsbury, director of the Psychological Laboratory at the University of Michigan, puts it, even the laboratory experiments offer little hope of reaching a definite conclusion on telepathy.

RECENTLY radio has been used in an effort to test mass telepathy. Sir Oliver Lodge directed such an experiment in London, announcing by radio the moment at which several persons in a locked room we.e concentrating upon certain undescribed objects. Out of the 25,000 listeners who next day sent in guesses as to these objects, so few were correct that only one conclusion could be drawn: Neither telepathy *nor* the theory of probability governed the results.

Professor Robert H. Gault, of Northwestern University, conducting a similar radio experiment in Chicago, reports negative findings.

So the radio experiments have failed to prove that telepathy exists. The laboratory experiments have failed; even Dr. Estabrooks, whose work has brought results at variance with those of other American experimenters, is today still unprepared to draw any positive conclusions from them. As Jastrow says:

"If we consider telepathy as a scientific hypothesis, the best we can say is that it is still on trial, with the odds enormously against it."

Nations Join to Sound Seas

(Continued from page 19)

of its echo. The device can make more than 14,000 soundings an hour while the ship is at full speed.

According to Commander N. H. Heck of the U. S. Coast and Geodetic Survey, American representative at the Prague meeting, the great survey is likely to reveal important knowledge of earthquakes and their causes; for three fourths of all the quakes originate in the sea. Their particularly active birthplace of tremors seems to be in the Pacific Ocean.

The plans include establishment of new seismograph stations for the study of earthquakes and the improvement of stations already existing. Then experts will be able to determine just where a tremor occurs, and to locate the slipping of rock formations which causes it.

The program will include studies of variations in the force of gravity. Objects weigh slightly more at some places on the earth's surface than at others. These differences are deemed important as indicating variations in the density of rocks. Until recently it was virtually impossible to measure gravity variations on shipboard, because of the rocking of the ship.

THE difficulty was solved by a young Dutch explorer, Dr. Vening Meinesz, by carrying the instruments undersea in a submarine. Not long ago he completed a submarine voyage around the world, making precise observations. His studies revealed that, while the force of gravity at sea averages about the same as on land, it is somewhat lower over the deeps; also that the rock formations far beneath the sea are unusually dense. These facts may have a direct bearing on the conditions of the earth's crust that resulted in formation of the canyons.

Before many years have passed new knowledge of earthquakes may have robbed them of their terror.

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Found—Whole New World Under Our Feet

(Continued from page 27)

leaf, every cornstalk, every dead rat, every particle of organic matter from which life has departed has been temporarily 'withdrawn from circulation.' If it were not restored to circulation, the whole volume of material available for new life would be lessened. After a while we would have only an earth piled high with carcasses and dead plants."

It is almost terrifying to think of the work of the soil population that is going on all the time! I asked Dr. Lipman if it could be stopped.

"Man can stop it for a while in a limited place. When food is canned, for example, the microörganisms are killed by heating, and the sealed-up contents will keep indefinitely. But open the can and a new set of the microscopic workers gets at it from the air or from water or from the earth.

"We can also use extremely low temperatures—freezing or cold storage. We can use poisons—as with embalming, or preserving in alcohol, or pickling. We can use disinfectants, like carbolic acid or formaldehyde.

"MUMMIES have resisted decay for thousands of years; embalming killed off the microörganisms. The Egyptians were aided by the fact that the air of the Nile Valley is very dry.

"Science is not alone in checking, at least temporarily, the work of the invisible empire. Since the microscopic workers require moisture, Nature dries out the things she needs to protect against the processes of decay—the plant seeds that have to be kept from season to season."

In the world of the soil are both plants and animals. There are different races and nations and tribes. Some clans are bitterly at war, some are friendly. I asked Dr. Lipman to tell me something about them.

"The biggest class," said Dr. Lipman, "is made up of bacteria. Some can move about, and others can't. Some partake of the habits of animal life, some plant, some both."

For their size, some of them can travel almost as fast as speeding automobiles! Some use feelerlike legs. Others move by doubling up and undoubling.

"The plant life," Dr. Lipman went on, "is composed chiefly of algae and fungi—tiny forms resembling slightly some of the larger plants we know.

"Protozoa can be classified as animals. They are largest and least numerous of all. Mostly they are roughly globe-shaped, or like tiny eggs dented on one side. When they want to eat anything they fold themselves around it, like little living stomachs—which is about what they are."

PROTOZOA unicellular organisms are the villains of the soil cities, eating millions and millions of bacteria, algae and fungi.

Imagine a big brute of a protozoan surrounding and eating one of the little bacteria, as an octopus might seize and crush and eat a kitten!

In an average soil population of, say, fifty million, in a cubic inch of earth, six or seven million may be algae and fungi and allied forms and a far smaller number protozoa. The balance of forty-odd million are usually bacteria.

Different soil population races have somewhat different functions. The duties of some of the bacteria are known; the exact functions of others are still unguessed.

"One of the earliest species to be classified," Dr. Lipman said, "was the nitrogen-fixing bacillus that lives in the roots of alfalfa. Whether it breathes out nitrogen while still alive, or gives off nitrogen when it is dead, has not been determined, but some way or other it stores up nitrogen in the soil. Alfalfa, like other members of the pea-and-bean family, requires lots of nitrogen. Without the aid of the nitrogen bacillus (Continued on page 123)

Found—Whole New World Under Our Feet

(Continued from page 122)

it takes what it finds already in the soil, impoverishing it greatly. But when the particular bacillus is present in great numbers, nitrogen is drawn from the air by the plant and furnished as food to the bacillus in its roots. The plants then grow larger, richer, and more luxuriantly. And the soil, instead of being impoverished, is actually enriched even though the alfalfa is cut and taken away, and only the roots are allowed to remain.

"When you realize that there may be as much as two tons of nitrogen in an acre of fertile soil, while infertile soils may have less than a quarter of a ton, the value of this nitrogen-fixing bacillus becomes evident. We have already imported more than two million tons of nitrogen from Chili alone, to be used in commercial fertilizer. Germany has developed a factory for nitrogen manufacture capable of turning out a product worth $100,000,000. But through the aid of science we now know how to enlist the underground population in the manufacture of nitrogen for us, and can do it almost without expense!"

Already agriculture experiment stations are selling, for fifty cents or less apiece, thousands of bottles of legume-bacteria culture for the innoculation of alfalfa seed. Last year the Agricultural College of the University of Wisconsin sold more than 50,000 bottles.

No one can say where the investigations into this new science will lead. Obviously, if our present civilization and accumulation of scientific knowledge continue, it may change the history of nations.

"ABOUT the middle of the last century," Dr. Lipman said, "the soil population of Ireland—for some reason we do not know—began to die off or change rapidly. As a result the potato crop failed. With successive years of failure the great Irish emigration to America began. Not only Ireland, but the racial history of the United States was changed."

Back in the middle of the fourteenth century, the Black Plague killed more than 40,000,000 people in Europe alone. Soil science is now revealing that the underlying cause, underlying even the presence of the bubonic bacillus in the black rats, was a change in the underground population!

Today the prevalence of goiter in southern Indiana and Illinois and certain other regions of the Middle West is due to lack of iodine in the soil, the scientists say. But the cause of the lack is a change in the balance of power of the bacteria and protozoa and fungi!

"An interesting recent experiment," Dr. Lipman concluded, "is one that we have been working on here at New Brunswick, in conjunction with the great English experiment station at Rothamsted, England. It throws light on the subject of the great fertility of partially sterilized soils—a matter that for a long time seemed to contradict squarely the fact that fertility and increased numbers of the soil population go hand in hand. To make sure that the two statements codpend efficiently in the research, a representative of our station went to Rothamsted, and one of the Rothamsted men came to watch our investigations. We found that partial sterilization of soil, through heating, kills off most of the microorganisms—but many bacteria are more hardy than their enemies the protozoa. Consequently, after the soil cools, and conditions for increase are right once more, the bacteria multiply unchecked until their numbers are even greater than before the partial sterilization. Hence the greater fertility and the apparent contradiction has been explained."

This one new revelation alone may change the productivity of whole areas, and with the change in crops and economic conditions, change their whole human history as well!

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Ford Gambles for Huge Stake

(Continued from page 47)

for a single tire, and that each of America's 25,000,000 motor cars uses four tires and probably a spare, you can understand why rubber has become a treasure worth gambling for.

Aside from the new plantation projects, the most promising possibilities for increasing the American supply lie in the growing of rubber-yielding shrubs and weeds and in the chemical production of synthetic rubber. The U. S. Department of Agriculture has succeeded in growing Para rubber seedlings in experimental gardens near Miami, and has cultivated more than a score of rubber-yielding plants.

Certain of these natives of desert regions have been tested in California and in arid valleys of the West. One in particular, the Mexican guayule shrub, now is producing rubber in commercial quantities in California. One of the common milkweeds growing profusely in southern Arizona and the desert regions of southern California is being studied especially, since it thrives in waste lands and yields large quantities of latex.

THE problem of successful rubber production in the United States, however, involves far more than growing such plants in large quantities. Machines and methods must be found for harvesting and extracting the rubber economically enough to compete with the extremely low labor costs of the tropical rubber plantations.

The same problem bars the way to commercial production of synthetic rubber. For years the chemistry of rubber has been understood. Fifteen years ago a British chemist, Prof. W. G. Perkin, produced rubber from potato starch, while a German, Dr. Carl Duisberg, exhibited synthetic automobile tires. More recently Dr. Fritz Hoffmann, German chemist and director of the Upper Silesian Coal Research Institute, in Freiberg, made synthetic rubber from coal tar. And Prof. James F. Norris of the Massachusetts Institute of Technology and Earl P. Stevenson of the Mellon Institute Laboratories at Cambridge, Mass., have shown that synthetic rubber can be obtained in great quantities from waste products of oil refineries.

NO DOUBT remains that artificial rubber is possible. In every instance, however, the cost of producing it has been too great for commercial success. Scores of research men in the United States and elsewhere are seeking the solution.

At any moment they may find the answer. A few weeks ago Dr. A. von Weinberg, a director of Germany's great chemical trust, said synthetic rubber would be produced from coal commercially and sold in competition with natural crude rubber. The new product, he said, comes from the discovery of a catalyst, or chemical accelerator, which simplifies the process of making the chief constituents of rubber found in coal tar. He declared the product equal in quality to natural rubber and cheaper to produce. Reports indicate it is an outgrowth of Dr. Hoffmann's discovery, which was impracticable because of high costs.

Still another source of supply, which is growing in importance, is found in reclaimed rubber. Last year one third of all the rubber consumed—200,000 tons in round numbers—came from the salvage of worn-out tires and other rubber goods. Thanks to improved processes and machinery, experts assure us that old rubber now can be made into good tires.

With experts of chemistry, engineering, agriculture and other fields of science joining in the search, it seems hardly likely that the feared rubber famine in the United States will materialize. Indeed, it is entirely possible that within the next few years we shall possess greater quantities of rubber and rubber goods at lower cost than ever before.

Why Don't We Fly Straight Up?

(Continued from page 44)

superstructure and football-shaped shock-absorbers beneath. This machine flew to a height of 150 feet with pilot and passenger in their precarious perch while a ground crew kept it balanced by tugging on attached ropes. At last it overturned, seriously injuring pilot and passenger; but it had demonstrated that given stability, a helicopter could climb to any height. No attempt was made to make this "captive helicopter" capable of controlled free flight.

Emile Berliner, American experimenter, sought to combine airplane and helicopter in a craft that could glide to a landing if anything went wrong. He spent a small fortune in the attempt. One of his later machines made a short flight, showing that it could be steered.

This type of craft could make a safe landing as an airplane only when it was high enough to pick up the forward speed that sustains an airplane in flight. Meanwhile the Spanish engineer La Cierva designed an airplane known as the "autogiro," with a huge motorless four-bladed windmill, free to revolve, above its fuselage. It could land at greatly reduced speed due to the added support of the whirling blades, demonstrating that a helicopter might be able to land safely without wings in case of motor failure if its propellers were large enough.

EMBODYING this idea in what appears the first automatically self-balancing type of vertical flying craft, Dr. de Bothezat built a true helicopter capable of steering and forward motion for the U. S. Army Air Service, with no preliminary models. When Col. T. H. Bane, Army Air Corps, "gave her the gun" for her maiden free flight, the craft shot ten feet into the air and started across McCook Field, O., at thirty to forty miles an hour. It descended, just as a fence loomed ahead, after a flight of nearly two minutes. This successful test was unique in that the inventor's first machine, existing before only on paper, flew at the very outset.

More than a hundred flights followed, and the inventor and his pilot learned to make the odd craft hover motionless above the ground. It once carried three passengers besides the pilot; another flight took it to a height of more than thirty feet, and it stayed in the air more than five minutes at a time.

Four propellers, designed for high lifting power, made the 3600-pound craft self-balancing by being tilted toward the center at an angle of about five degrees. As soon as the helicopter swung from an even keel and consequently moved in the direction of the sway, air currents striking the under side of the near propeller and the upper side of the far one automatically righted it. To steer the craft an airplanelike "joy stick" in the pilot's hands flattened out the propeller blades on one side and increased the pitch of those on the other, thus tipping the whole machine in the air and causing it to "drift" horizontally. In case of motor failure, the 900-square-foot area of the propellers compared favorably with that of an airplane's wings; the machine could settle gently straight down, according to the inventor, with its released screws whirling.

BEFORE attempting a free flight to a great altitude, Dr. de Bothezat hoped to construct a helicopter along the same lines with certain improvements for added endurance. But the Government was unwilling to undertake the additional expense, and all experiments were abandoned—temporarily at least.

This relatively simple matter of endurance, Dr. de Bothezat maintains, is the principal remaining problem of helicopter design. It should be possible to simplify the design of a vertical-flying machine and to construct it of light materials, in a way that would assure its success.

How to Select Your Lumber

(Continued from page 65)

"Its place as framing lumber has been ably taken by Douglas fir the last few years. This is a tall native of the Pacific coast. The lumber is reddish brown, with few knots, easy to work and extra durable because it is mostly all heartwood. It has fine grain and uniform texture and is especially suited for studs, joists and rafters as well as porch ceilings, while it is often used for porch floors and railings. It is perhaps the best compromise or all-around lumber for inside and outside. Of course no compromise is equal to a specialty for a given purpose, and we have better woods for entirely exposed positions."

"For example?" inquired the young man.

"CYPRESS, which has no peers in resistance to decay except maybe white pine, redwood and red cedar. The tree grows in Southern swamps and thereby seems to learn the secret of endurance. Water pipes of bored cypress logs have lasted in the South almost a century; cypress shingles in the North, about twice as long. The wood is soft, reddish and has a pleasant smell. It does not warp and requires paint or stain for appearance rather than for protection. It is recommended for everything outside a house, and many persons like it for interior trim. Since moisture and heat do not affect the wood, it is desirable in laundries and kitchens."

Alice remarked, "If cypress has all those merits, why should we look further? Why not build our entire house of cypress?"

"Because it would cost more," replied Mr. Morton, "and because a proper combination of woods makes a better house than any single wood. Cypress is not perfect against hard wear, as in a floor. In trim it tends to be splintery, being usually sawed flat grain. We may use it for an open porch floor because weather protection is most important there. Oak or common pine on the porch would soon warp, then decay. It would be wasteful to use cypress as sheathing or subflooring where common cheap lumber would serve. However, you might justify cypress sheathing or inside paneling on the ground that this wood has special insulating value."

"I AM a little mixed on the quarter sawed versus flat grain question," said George.

"In general, quarter sawing is superior for looks, wear and nonwarping," said Mr. Morton. "It is most essential in common pine flooring, less in hardwood and cypress. The latter is not inclined to warp anyway. Hardwood is supposed to be protected from dampness, and its tough fibers do not readily yield splinters even in flat grain. In quarter sawing the log is first quartered lengthwise into four pieces, after which boards are sliced from each section. You can see why the product is sometimes called edge grain or vertical grain. Rift sawed is another alias. The board surface shows fine lines along its length, each line being a growth ring. In flat grain the log is squared and sliced into boards. The surface lines are irregular and broken with shiny islands that may later become ridges and splinters."

"Is the wood that cedar chests are made of used in building a house?" asked Alice.

"Generally not. Virginia or eastern red cedar, a small tree, is worked into chests. The western red cedar, a giant of the Pacific coast, is widely used for siding, clapboards, shingles and all exposed parts of a dwelling. It is one of the best weatherproof materials—light, soft, a good insulator, with a pleasing surface for natural finish and well adapted for paint. The size of the tree insures knot-free lumber in all widths and lengths, hence western red cedar has largely taken the place of white pine for siding or clapboards. The color does not quite fit the name, being brownish buff. You can tell it also by its spicy *(Continued on page 127)*

How to Select YourLumber

(Continued from page 126)

odor. A good many people line closets with cedar in thin matched boards or a new style of veneer. The idea that this makes the closet moth-proof is not supported by Government scientists."

"People don't like the cold facts, do they?"

"Not every day," laughed the lumber merchant. "We nearly all like to be flattered in our ignorance. Now that we're talking about decay-resistant timber, we might as well consider redwood. This native of California doesn't get very far east. Redwood is to the Pacific region what cypress is to the Atlantic. It is a relative of the mammoth Sequoia or big tree, and I guess is next in size to that world champion of the forest. Sound lumber has been manufactured from a redwood log that had lain on the ground six hundred years. Five years on the ground is enough to ruin many trees whose lumber is used in building. Redwood has no resin and hence is fire-resistant and takes paint well. But paint is not needed for protection, and the usual finish for interior trim is wax, which brings out the natural grain and color, between light cherry and mahogany.

"I HAVE heard of American gumwood," said George. "What is it used for?"

"Interior trim and cabinetwork," replied Mr. Morton. "It is a hardwood of fine grain that sometimes runs into ornate and intricate patterns, used for decorative paneling. This is known as figured gumwood, while the usual sort is called plain, although it shares some of the attractive features of the silver. The color is a reddish brown, with more of the former hue in the heartwood, classified as 'red gum.' This is favored for all kinds of interior woodwork and is usually given a natural finish with a filler coat of paraffin or linseed oil. Stains may be used, and it is customary to apply enamel on household conveniences that are built of sapwood or the lumber from the outside of the tree. It is well to have gumwood quarter sawed as a protection against warping."

"I am anxious to know all about oak flooring," announced Alice.

"You will have no anxiety with an oak floor," laughed the merchant. "Take your choice between white and red. There is no great difference except in looks, one being a light tone and the other dark, and slightly less cost for red. Oak flooring is now made in three nominal thicknesses, inch, half inch and three eighths. By universal trade custom the actual thicknesses are less. I don't advise as thin as three eighths unless perhaps to recover an old double floor. Naturally, thin stuff costs less. It needs a rigid base. Some of the thin material is ready finished at the mill. The heavier grades are hollow-backed to prevent warping. Narrow strips are preferred, and a bit more expensive because of wastage in matching. In length, take the usual assortment of long and short pieces if you want to save money."

"Maple is next to oak, isn't it?"

"NEXT above it in hardness and price, which is news to many persons," was the reply. "You see it in public buildings, hotels, schools and dance halls. It wears like iron and there is not a sliver in a carload. The color is silvery gray, or something like that. The best quality is called 'clear,' and the next is No. 1, with which most home owners would be well satisfied. Like oak, all this flooring is end matched as well as side matched, so that short lengths are securely held in place."

"We have learned a lot about lumber, Mr. Morton," said Alice, "and we thank you. But now I wish you would take our plans and just pick out the kinds of wood we ought to have. We trust you."

The lumber dealer laughed appreciatively.

Toys That Save Millions

(Continued from page 18)

talk of raising it to a hundred feet or until it collapses, but already the sensitive instruments imbedded in its concrete have given through electric wires valuable figures on deflection and interior stresses. And measurements with a nonvarying tape of invar steel show the dam with water behind it actually spread apart the mountains of the canyon!

Prof. Beggs' one-fortieth size model of this dam was tested—using a tank of mercury instead of water so that measurable deflections would be given. The only difference between deflections of model and dam was due to two tiny cracks in the concrete that upset the instrument reading. Now Beggs, under auspices of the foundation, makes celluloid models of all types of dams, measuring their deflections through needle-tipped rods and also with the aid of a marvelous instrument loaned by the U. S. Bureau of Standards—an optical strain gage reading to a millionth of an inch!

AT THE Bureau of Standards a different sort of investigation has already revealed surprising new facts showing how skyscrapers should be designed. Within a huge wind tunnel, housed in a building appropriately called "The Cave of the Winds," models of skyscrapers, bridges and factory chimneys are subjected to enormous wind action to find how they behave. Preliminary results seem to show that suction rather than pressure causes buildings to collapse in excessively high winds; they "explode" outwardly! Now the experts are learning how to design a "streamlined" building that offers the least resistance to the wind. They know, too, what forces a high wind unleashes as it whistles around a smokestack. Twenty-four pressure gages are attached to holes that pierce the circumference of a thirty-foot experimental stack on the laboratory roof.

Tests of a full-sized bridge under forces likely to wreck it, marking an event unique in engineering history, have just been made possible. When a new dam heightened the level of the Pee Dee River, and the thousand-foot concrete bridge near Albemarle, N. C., was rendered useless, state highway engineers obtained permission to test the old span before it was removed. A movable tank that weighed, when filled with water, 115 tons, was hauled from place to place on the bridge and the sag was measured.

These tests have been completed with the bridge in its original condition. At this writing, the engineers are now removing all arch bracing to compare with previous results the behavior of the bridge under a load when it has nothing to stiffen it.

Out of these tests of models and actual structures is likely to come a new science of structural engineering. Already several universities in this country are teaching young engineers the use of the newly-invented celluloid models. To the engineer's handbook of formulas to design ordinary structures there is added information for any unusual and baffling problem.

BRIDGE-BUILDING, for instance, has a history almost as long as man's, yet here is a new and revolutionary tool in the hands of bridge builders. Yesterday a huge "skew bridge," the Monier Arch at Bendigo, Australia, collapsed with loss of life and showed our mathematical theory of such slantwise-built arches inadequate. Today skew bridges are being designed with models that will resist any load they may be called upon to bear. And with the extension of difficult structural design from the hands of the few engineers qualified to perform intricate calculation to the many who can use the new ways, a modern era of beautiful and sturdy structures is sure to dawn.

Dodging Death on the Wires

(*Continued from page 37*)

safety belt. I was out two hours and a half —a record, I guess. But they kept the pulmotor going and the next thing I knew a dozen red-hot needles were pushing into my chest.

"The 'juice' generally ties a man's muscles in knots and makes him swallow his tongue. When you try to get his tongue free his jaws may clamp down on your fingers. I jam pliers in his mouth. Once the tongue is free you use artificial respiration."

The current a man can stand depends on the man—largely on his heart. Five hundred and fifty volts is said to be fatal, but one lineman, standing in dry boots on a dry cement walk, took "five-fifty" and barely felt it. Still, men have been killed by a hundred and ten.

Joe Moran, a cable splicer, a veteran like Bill, pointed out the high-tension electric light and power wires, called high lines, often on the same poles with telephone wires and carrying 33,000 volts and upward.

"A lineman can work barehanded on phone wires; there's only the twenty-four-volt battery current in them," said Joe. "But in a bad storm there might be a high-voltage cross somewhere up a jointly used pole, and then —" Moran shrugged.

"IF A lineman's in good physical condition there's always a little body oil on his hands, which may serve as insulation and help him a little, but if there's a small cut on his hand, the 'juice' will find it and go through him. Worst shock I ever got was from opening a terminal box and getting stung by a swarm of bees I'd disturbed. Ants and squirrels cause trouble, too, chewing the cable. One 'trouble shooter' found a short circuit caused by a spider web strung across open wires and covered with dew."

Odd accidents are not infrequent. "A fellow out west named Hosler," said Bill, "climbed a pole to loosen a crossarm where the cable had sagged going over a river. A log jam had reached the cable and put a devil of a tension on it. The cable snapped and the pole, with the tension relieved, catapulted Hosler a hundred feet into a grove of firs.

"This isn't so funny," said Moran. "A lineman in Canton, O., looked down and saw four gunmen in a motor car kidnap a policeman who had halted them. He tapped the wire and notified the police. Well, three of the bandits were wounded and the other was killed."

LINEMEN generally have an induction coil and transmitter with a pronged clip to pierce the wire insulation and call central. "Trouble shooters" have test sets with generators to ring the operator. Often this equipment, as in the Canton episode, renders more than telephone service. Frank Ciccarino was on a pole when a little girl rushed from her house, crying that her father was overcome by gas. Ciccarino cut in, called a doctor, dropped forty feet, and with first aid had the man out of danger before the physician arrived.

A Michigan lineman tapped a wire in time to hear a newlywed mother call a far-away doctor. Her small son had cut an artery. The lineman raced to the house and with a tourniquet saved the child from bleeding to death.

And so it goes—curing wire trouble, and other trouble, too. Ordinary wire difficulties, I learned, are fairly well provided against, but it would cost untold millions to make the service proof against the unusual, such as tornadoes and blizzards—and it is things like these that make linemen work almost till they drop, resetting poles, digging out tangled wire and frozen wire and wet wire, splicing and tying in new lines—cleaning up dangerous wreckage —and dodging death. The first rule is service at any cost for the 50,000,000 calls a day on America's 17,000,000 telephones.

Stars Hold Secret of Life

(Continued from page 21)

A blue-eyed young daughter of the American farmer took the greenhorn in hand and taught him the English language. She looked exactly like a Serbian vila, or fairy, and acted like one. She suggested there might be wider opportunities in this country than driving mules on a farm. So with fifteen dollars saved from wages, Pupin went to New York and bought stylish clothes from the riotously competing merchants of Chatham Square. A friend slapped him on the back and said, "Who would ever think you a Serbian greenhorn?"

Michael's friend, a young German named Christian, got him a contract to paint a baker's wagon for five dollars. The first rain washed off the paint. Michael was troubled when he learned it was his fault because he had put no dryer in the paint. His friend laughed:

"Don't worry, it serves him right. He wanted a twenty-dollar job done for five dollars, because he took you for a greenhorn."

It cost the baker another five to have the job done over.

PUPIN moved to a hall room near Cooper Union for the benefit of a free library. He followed coal carts, ringing the householders' bells and offering to shift the coal inside at fifty cents a ton. Once inside there was a chance for more work, painting and the like.

Later he found steady work in a cracker factory. Jim, the boiler room engineer, accorded him the privilege of being a volunteer fireman in his spare time and encouraged him to attend night school at Cooper Union.

"He was my first professor in engineering," says Pupin. "The first ideas of sound and light I caught on the pasture lands of my native village; the first ideas of the phenomena of heat I caught in the boiler room in Cortlandt Street and in Cooper Union lecture rooms."

Through attending Henry Ward Beecher's famous church, Michael found a benefactor. He obtained a job in a doctor's office and entered Adelphi Academy. He made a hit at the academy by winning a ten-mile race. His athletic prowess made him popular at Columbia College, through which he later worked and tutored his way.

He won scholarships at Columbia and went to Cambridge University in England for post-graduate study. The home of Faraday and J. Clerk-Maxwell, fathers of electrical science, had a great fascination for him. In Paris he picked up a bargain—the mathematical masterpiece of La Grange, the Newton of France, entitled *Méchanique Analytique*. The musty book, a hundred years old, had more thrills for the buyer than the best novel.

THIS book gave Pupin the clue to the solution of the problem of hard and soft ground in conveying messages on the Banat plains. Suppose the ground is hard in spots, won't it carry better than if it is all soft? The answer, translated to the electrical field, is an epoch-making yes. Pupin inserted a series of hard spots in the form of coils in electrical conductors, thereby tremendously increasing the carrying ability of telegraph and telephone wires.

When Pupin referred to principles of his loading coil in a scientific paper published in 1899, a friend urged him to obtain a patent. Pupin followed the advice barely in time to protect his invention, which was sold a year later to The American Telephone and Telegraph Company. "The Company gave me what I asked," says Pupin; "my friends thought I had not asked enough." But to the former peasant boy the sum was more than ample.

Another boyish inspiration came from a village musician. Says Pupin: "Few things excited my interest more than the operations of the Serbian bagpiper as he forced the air from his sheepskin

(Continued on page 151)

Stars Hold Secret of Life

(*Continued from page 130*)

bellows and made it sing by regulating the passage through the pipes. The operations which the bagpiper called adjustment and tuning commanded my closest attention. I never dreamed that I should do a similar operation with an electrical circuit. I called it 'electrical tuning.' The operation was first suggested to me by the bagpiper, some twenty years before I made the invention in 1892."

Nobody, including the inventor, thought much of the commercial value of the discovery at the time. His invention of electrical tuning seemed to have no important application until Marconi developed his wireless system.

Then one morning, after Marconi had developed his wireless system, a stranger stepped into the professor's office at Columbia and asked,

"Are your wireless inventions for sale? How much?" "It was Mr. Green, organizer and promoter of the Marconi Company of America," says Pupin, "I gave him the first figure that came into my head and he asked if I would take half in cash and half in stock. I asked twenty-four hours to decide."

Pupin would have been "perfectly satisfied to accept the cash without the stock, but I was afraid that any over-anxiety might scare him away. The next day he called and the deal was closed."

Pupin is simple in his tastes, unpretentious, friendly and eager to help everyone with whom he comes in contact. His country home in Connecticut reflects his boyhood environment with a goodly cattle barn and silo right next to the stone mansion. The same stars are visible in Connecticut that instructed and inspired him in the Banat long ago, and he looks to them for further guidance.

HE USED to spend earlier vacations mountain climbing in the Alps and in visits to the home village during the lifetime of his mother. The villagers, always glad to see him, listened to his stories of America with interest and polite skepticism. Once he received a cablegram from America. An old native said that to send a message so far over land and sea the Americans were very clever. Pupin agreed.

"Then," demanded the old man, "how in the name of St. Michael do you manage to make a living there?"

When Pupin established his country place in Connecticut he spoke for good roads at a town meeting and was severely rebuked as a city intruder by the oldest voter present, a Mr. Nettleton. Two years later Pupin befriended a homeless potter dog, who became his constant companion. One day Pupin on horseback was halted by Mr. Nettleton, who said:

"Professor, I was severe with you two years ago. I didn't know you. That dog there would not stay with anybody in this town, but he stays with you, and he follows you just as he followed his master. Shake. I shall never oppose you again."

Pupin, the scientific philosopher, has long pondered the origin of life and has seen an answer both scientific and devout. Thus he has said:

"Every physical fact has two terminals—one in our consciousness and the other in some star which is rejoicing in the blazing vigor of its youth. Just explore the path which leads from one of these terminals to the other, and you will discover on each side those beauties which continually thrill the heart of a scientific man. Do that and you will never again speak of the cold facts of science.

"Who has not heard of Einstein and of his verified prophecy that a beam of light will be deflected by gravitational force? A beam of light represents electrical energy and electrical energy is gravitation- (*Continued on page 132*)

Stars Hold Secret of Life

(Continued from page 131)

ally active just like any other mass considered by Newton. A star radiating light radiates electrical energy, and therefore it throws out to us a part of its own mass.

"When this radiation reaches us we can say, therefore, without indulging in figures of speech, that the star is visiting us. I am not indulging in a flowery figure of speech when I call solar radiation the balmy breath of the heavenly bridegroom, the glorious sun.

"Fifty years ago, instructed by David's psalms, I found in the light of the stars a heavenly language which proclaims the glory of God, but I did not know how that language reached me, and I hoped that some day I might find out. That hope was in my soul when I landed at Castle Garden. Today science tells me that the stars themselves bring it to me. Each burning star is a focus of energy, of life-giving activity, which it pours out lavishly into every direction of the energy-hungry space; it pours out the life of its own heart in order to beget new life. Oh, what a beautiful vista that opens to our imagination, and what new beauties are disclosed by science in the meaning of the words in Genesis: 'He breathed into his nostrils the breath of life, and man became a living soul.' The light of the stars is a part of the life-giving breath of God. I never look now upon the starlit vault of heaven without feeling this divine breath and its quickening action upon my soul."

PUPIN sees the universe as microcosm and macrocosm. The former, below our vision or that of the highest powered microscope, is changeless and the seat of immutable power. The latter or visible world is quite transient and relatively feeble in energy. He says:

"The elements of the microcosm, the electrons in the atom, are, as far as we know, immutable and immortal, because man knows no natural process by which the electrons and the laws they obey can ever be changed. They are not the product of any natural process of evolution known to man.

"To discover the immutable laws which this substantia, this immutable foundation of the universe, obeys is the highest aim of scientific research. The existence of these eternally unchangeable things brings us face to face with a power which is the eternally immovable background of all physical phenomena. We feel intuitively that science will never penetrate the mysteries beyond it, but our faith encourages us in the belief that there, behind the impenetrable veil of the eternal background, is the throne of a divine power, the soul of the physical world, the activity of which we contemplate in our research of physical phenomena."

Evolution rules in the visible world from nebula to star and from amœba to man. It is an upward process from chaos to cosmos, as the Greeks called it, from the noncoördinated to the coördinated, from anarchy to law, from disorder to order, from unfitness to fitness, from destructive combat to harmonious and fruitful peace.

Will evolution produce a super-man?

"Yes," says Pupin, "either as an individual or as a member of an ideal democracy."

We should be satisfied either way.

A wonder story of inventive genius and scientific achievement is the life-work of Elmer A. Sperry, to be told in the March issue of POPULAR SCIENCE MONTHLY. How one man was able to perfect the gyroscope, build the world's most powerful searchlights, create electric automobiles, and erect the highest electric beacon in the world on the shores of Lake Michigan is the subject of a fascinating account that explains why nations have showered him with medals and honors.

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The name of the first man has long since been forgotten; the name of the other, the humble clerk in a country store, will live forever.

He talked like a man who had traveled, though his travels were confined to a few backwoods counties. He knew something of history and biography of the work of great philosophers, poets and dramatists.

He owned a few great books and, in the odd moments between customers' calls, he read them systematically. It was the influence of those books that gave his mind its start; then lifted his eyes beyond the horizon of a backwoods town. Before he was fifty, the whole nation knew the name and acknowledged the power of that humble, unschooled man. Has name was Abraham Lincoln.

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Here Are Correct Answers to Questions on Page 57

1. On the islands of Spitzbergen, north of Norway, which belong to that country, are extensive deposits of coal. To some extent this coal has been mined, but the severe winters and the long periods of continuous night make it difficult and expensive to maintain any industrial operation in these islands.

2. This is the meaning of the native word from which the name of the Amazon River was derived. Before the coming of the whites, the natives evidently had trouble in navigating this mighty stream and named it accordingly.

3. An island more than 1000 square miles in area, just south of the west end of Cuba. The name refers not to any growth of pine trees, but to pineapples produced on the island in considerable quantity and of high quality.

4. Off the coast of lower California, centering around the town of La Paz. In the years immediately preceding the great war, the La Paz fisheries had become the third or fourth in the whole world. During the war the industry declined somewhat, but gradually it is regaining its importance.

5. Alaska was colonized by Russians. In 1799 the seat of a Russian government was founded at what is now the city of Sitka. This city remained the capital of the Russian possessions in America until the purchase of Alaska by the United States in 1867.

6. Along the bed of the Mississippi River there grows a shellfish of the mussel family, the shells of which are used to make pearl buttons. The young mussels attach themselves to the gills of fish. These fish swim around, the tiny mussels fall off, and thus the young mussels are "planted" over the bottom of the river.

7. In the desert regions of California, Nevada, Utah, and Arizona, the ground is covered frequently with loose sand, forming great dunes. Automobile wheels will sink into this and be unable to move. To pave the roads with concrete is usually too expensive. Accordingly, roads often are covered with straw or brush.

8. The name of "trade winds" is given to the winds that blow, with great regularity, over the main ocean areas. In the northern hemisphere the trade winds blow from the northeast to the southwest. In the southern hemisphere they blow from the southeast to the northwest—of course with certain local variations. In the United States, it is the trade winds blowing from the Pacific that make San Francisco such a windy city and that are responsible for the cool and healthful climate of that part of the California coast.

9. If one ignores the many kinds of wild plants, seeds of which probably were gathered by prehistoric man, the most ancient grain is almost certainly wheat. It is believed wheat grew wild thousands of years ago on the mountains of Syria.

10. The only one that would certainly be visible to an astronomer located at that distance would be the Great Wall of China. The wall is long enough to reach from Philadelphia to Kansas City.

11. This is the habit of a variety of ant found in central and eastern Africa, especially in Kenya Colony. The sting appears to be stuck together with some glutinous substance. Often these hills are quite steep, looking like skyscraper buildings.

12. The pygmies, who live in the jungles of the Congo region, are usually less than four feet high. They creep up with sharp knives and slash the elephant's legs. He then is nearly helpless and can be dispatched without difficulty.

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I'll pay men $100 a week for selling our tailored to measure all wool suits and overcoats at $23.50 and $31.50. Highest commissions. Extra Bonus for producers. Large swatch samples free. W. Z. Gibson, Inc., 500 Throop St. Dept. P-672, Chicago

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Ladies make $15.00 a day introducing new "Christmas Eve" delightful French perfume. Ounce bottle worth $7.85. You sell it for $1.25. Make 50c on each sale Write for full particulars or send $1.25 for demonstrating bottle, which guarantees quick sales Sorel, Parfumers, 551 Fifth Avenue, New York.

$25.00 daily selling colored Raincoats and Slickers, Red, Blue, Green, etc., $2 95. Hat Free. Pay daily. Outfit Free. Elliott Bradley, 241 VanBuren, Dept AF-2, Chicago.

America's Greatest Tailoring Line Free! 130 large Swatch Samples—All Wool—Tailored to Order—Union Made—Sensational low price. Get outfit at once. Address Dept. 306, Goodwear, 844 W. Adams, Chicago.

$5,000.00 Given. 350 Cash Prizes. 350 persons—men, women, boys, girls, who send me their names get prizes—from $5 00 to $2,000 00—with $500 00 extra for promptness. Horse Creek, Wyoming, man won $1,735.00. Woman in Claysville, Pa., won $1,000 00. I make this offer becaus I want to send everyone who answers this announcement an absolutely free sample of my products. Send no money! No obligation. Nothing to buy—now or ever! Just say "How can I get a prize? G. L. Culver, Room 9, 500 North Dearborn St., Chicago, Ill.

Sell beautiful "Style Tailored" shirts and neckties direct to wearer at factory prices. Many beginners earn $50 first week in spare time $100 weekly full time easy. Selling outfit Free. Howard Shirts, 1219 Van Buren, Factory 10, Chicago.

Why not sell us your spare time? $2.00 an hour, $19.70 daily easy full time. Introduce 12 months Guaranteed Hosiery—47 styles, 39 colors, for men, women, children, including latest "Silk to the Top" Ladies' Hose. No capital or experience needed. We furnish samples. Silk hose for your own use FREE. New Plan. Macochee Hosiery Co., Road 9282, Cincinnati, O.

IF IT'S NOT HERE WRITE US!

Here is a new service for the convenience of our readers. If you are looking for certain articles listed below, write P.C.S. Information Dept., 9 East 46th St., New York. For each item to be investigated, please enclose 10c. *to cover cost of postage.*

Men's Wear
Belts, Collars, Gloves, Handkerchiefs, Lumber Jackets, Knickers, Mufflers, Pajamas, Slippers, Shoes, Underwear

Auto Supplies
Auto Tires, Carburetors, Dimmers, Gas Savers, Rear View Mirrors, Tire Patches, Pliers, Wrenches, Auto Polish, Spark Plugs, Trouble Light

Food Stuffs
Canned Goods, Coffee and Tea

Men's Specialties
Ash Receivers, Initialed Billfold, Suit Hangers, Pencils, Watches

Household Specialties
Brushes, Fire Extinguishers, Mending Fluids, Mothproof Bags, Moth-killing Liquid, Paints, Vacuum Cleaners, Window Washer

Kitchen Specialties
Aluminum Cleaner, Can Openers, Cookers

Women's Wear
Aprons, Coats, Sanitary Belts

Women's Specialties
Hosiery Mender, Jewelry, Sanitary Goods

Home Furnishings
Dishes, Linens, Nursery Stock

Electric Devices
Curling Irons, Hot Plates

Miscellaneous

Agents $240 month and auto to travel in. Bonus besides. Introduce new line guaranteed hosiery for men, women, children. 126 styles, colors. Beats store prices. Guaranteed to wear 7 months or new hose free. Finest line Silk Hosiery you ever saw. New sales plan. Credit given. Spare time satisfactory. Write for samples. Wilknit Hosiery Co., Dept. 835, Greenfield, Ohio.

Women Representatives Wanted. New invention prevents shoulder straps slipping. No more discomfort. Women adore it. Write for particulars and free offer Lingerie "V" Company, 5 Lake St., North Windham, Conn.

New lines just out. Everything in hosiery, underwear and Rayon lingerie for men, women, children. Beautiful, irresistible Catalog and Samples now ready. New special big money plans. Cash bonus, service awards, rapid promotion. No capital needed. Choice territories going. Rush reply to World's Star Knitting Co., 112 Lake St., Bay City, Mich.

Don't worry with small profits and unknown articles! Backed by tremendous national advertising, hundreds of Nogar salesmen are making $500 to $1,000 monthly Right Now. World's longest wearing suits, $12.50. Amazing wear demonstration makes big, steady sales certain. Write today for Free Kit, full starting instructions. Nogar Clothing Mfg. Co., Dept. CS-2, Reading, Pa.

Men, get Forest Ranger job; $125-$200 month and home furnished; permanent, hunt, fish, trap. For details, write Norton, 270 Temple Court, Denver, Colo.

Punchboard Salesmen Take Notice. New fascinating game "Excitement." Can be used all states. $200 weekly easy. One minute sales talk. Pay daily. Cigar Stores Novelty Co., Dept P, Peoria, Ill.

Agents; 500% Profit Free Samples Gold Sign Letters for Stores and office windows. Easily applied. Large demand everywhere. Metallic Letter Co., 431 N. Clark, Chicago.

New Invention beats vacuum sweeper and all its attachments. Electricity unnecessary. All complete $2.95. Over 100% profit. Morgan, Mrg., 797 Grimes St. Fairfield, Iowa.

Saleswomen, Salesmen make big money, taking orders for our beautiful Dress Goods, Silks, Wash Fabrics. Handkerchiefs, Hosiery, Fancy Goods. 1000 samples furnished. National Importing Co., Dept. B-89, 573 Broadway, N.Y.

Be a Real Estate Expert. $5,000-$15,000 yearly. Experience unnecessary. I'll teach you everything. Connect you with my chain of real estate experts. Write for FREE booklet. National Real Estate Institute, Dept. 500, Fort Smith, Ark.

Great neckwear line now free! Features finest quality neckwear at factory prices Collect big commissions daily. Write for FREE tie offer and FREE outfit. Nawco Neckwear, Desk B-125, Covington, Ky.

Why work for others? Employ agents yourself. Make your own products. Toilet articles, household specialties, etc. 500% profit. Valuable booklet free. Nat'l Scientific Laboratories, 1925-W Broad, Richmond, Va.

Free: Wholesale Specialty Catalog, showing best sellers from many parts of the world. Many home and office articles listed. Sporss Impt. Co., Lesueur Center, Minn.

Sell Men's Fine Suits (extra trousers free) for $16.95 $90 a week for you, also tailored pants. $3.95, ($5.00 value). Big extra commissions. Both sample outfits free if you write quick, Tru-Fit, 808-A Broadway, New York.

Quick Cleanup for Live Agents! Cash in on this craze for Colonial rugs sweeping country. Every housewife buying. Agents earning $100 weekly. Bettermade Puritan rugs sell at half store prices. Big commissions advanced. Write for offer. No obligation. Puritan Rug Co., 552 South Street, Waltham, Mass. Dept. 369.

Send 25 Cents for a $1.00 Pocket Cigar Lighter and learn how to make $10.00 a day Easy. Sells on sight. Particulars FREE. Rapid Manufacturing Co., 799C Broadway, New York

Women! Earn $3-$6 an Hour. Display beautiful Fifth Ave. dresses to friends. Factory prices. Cash commissions in advance. Pleasant work. Exp. unnecessary. Write Fifth Ave. Styles, Dept. 1002, Scranton, Pa.

Make Big Money representing the only firm that guarantees shipment of genuine Tailored-to-Measure Clothing within 10 days after receipt of order. Complete $23.50 and $29.50 lines. Big commissions. The Style-Center Tailoring Co., Dept. B-20, Cincinnati, Ohio.

New Rubber Goods Line. 47 Money Makers. Aprons, Baby Goods, Sanitary Garments, Gloves, Rubber Rugs, Cushions, Shopping Bags, etc. Big profits. Best values. Deal with factory at Rubber Center. $90 weekly easy. Credit given. Write quick for territory. Catalog and Free Outfit Offer Kristee Mfg. Co., 92 Bar St., Akron, Ohio.

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We refuse over $3,000 worth of questionable advertising every month.

But if you do business on the basis of "satisfaction or money back" write us.

For rates in this and other magazines address Publishers Classified Service, 9 East 46th St., New York.

Amazing New Glass Cleaner offers you $15 a day sure! Cleans windows, windowshields, show cases, etc., without water, soap or chamois. No muss. Easily demonstrated. Housewives, motorists, garages, stores, institutions buy on sight. Write for Special Introductory Offer. Jiffy Glass Cleaner Co., 1661 Monmouth, Cincinnati, O.

Earn $80.00 weekly with Fashion Frocks for women. Big line new styles at factory prices. Big advance commissions. No experience necessary. New plan! Fashion Frocks, Inc., Dept. M-100, Cincinnati, Ohio.

Old estab. mfg. co. gives you credit; starts you in business (city or country) selling 185 widely known household necessities. Permanent business; steady customers; large profits. McConnon, Dept. TH2, Winona, Minn

Ankrum Advertising Agency, A20 W. Jackson Blvd., Chicago, Ill., specialists in direct selling, mail-order and poultry advertising. Service circular and catalog on request.

No Dull Times Selling Food. People must eat. Federal distributors make $3,000 yearly and up. No capital or experience needed; guaranteed sales; unsold goods may be returned. We furnish you with sample case, license and Free Samples for customers—Sure repeat orders. Exclusive territory. Ask now! Federal Pure Food Co., R2311 Archer, Chicago.

$1,000.00 Reward if this is not the greatest money-making house to house proposition ever known. N.R.G. tablets wash clothes in 10 minutes without rubbing. Free Samples N.R.G. Co., P232, W. Superior, Chicago.

Sell by Mail! Spare Time. Big Profits. Books, Novelties, Bargains. Ready Made Circular Service. 48-page Catalog Free. M. Elfco, 525 S. Dearborn Street, Chicago.

Amazing 512 page book—"Safe Counsel," tells the truth about sex. Explains the Laws of the Love-life. Scores of intimate subjects 104 chapters, 121 illustrations. Send no money—Write for a copy. We'll send our regular $4.00 Gift Edition. Pay postman only $1.98, plus postage upon arrival. Satisfaction guaranteed. Catalog Free. J. Z. Smith Co., 800 N. Clark Street, Chicago, Dept. 4700.

Ladies, reputable manufacturer offers you opportunity to make extra money spare time, experience unnecessary. No selling. World Mfg. Co., 346 6th Avenue, New York.

DISTRICT SALESMAN — All wool, Union Made suits, overcoats, $23.50. Liberal advance commission, bonus. Write for large FREE outfit. O. W. Harvey, Box 00, Chicago.

DISTRICT MANAGERS

Producing Managers who know good tailoring and genuine value, write or wire for information. All wool and pure worsted suits and topcoats at $18.75 with $3.75 to salesman and 7% to manager. Outfits free. One of the largest companies in America. We back every garment. Canterbury Tailors, 22 West 22nd Street, New York.

Finest shirt line in America with best selling outfit. Big doubled swatches. Outfits free. Prices and commission arrangements right! Send full information about yourself and your record. Confidential. Sales Mgr., 20 West 22nd Street, New York

If you can sell the finest tailoring in America at a price which means big profits to you, you need the Leonard Line. Features yard and a third display lengths. The kind of fine hand tailoring clothes bankers, lawyers, business men wear. Special imported woolens. Unless you can sell 150 suits a season don't write. Leonard Custom Tailors, 12th Floor, Leonard Building, Cincinnati, Ohio.

$1000 Profit in 6 weeks by "Miller." New. Amazing Cleaner. Cleans Everything. 250% profit. Sample free. Bestever Products Co., 4325W Irving Park, Chicago, Ill.

POLMET POLISHING CLOTH.—Cleans all metals, gets enthusiastic attention, sells fast at 25c; sample free. F. C. Gale Co., 99 Edinboro St., Boston, Mass.

New Household Device washes, dries windows, sweeps, cleans walls, scrubs, mops. Costs less than brooms. Over half profit. Harpers, 530 Third St., Fairfield, Iowa.

Clear $75-$100 weekly writing orders for Peerless made-to-measure, rain-proof caps—also famous Aero caps. $1.00 profit—$2.80 sale. Outfit Free. Peerless Co., Dept. N-85, Covington, Ky.

Get 1000 money making opportunities from reliable firms Free. No obligation, send name and address. Salesology Magazine, 500 N. Dearborn, Desk C-1, Chicago, Ill.

Tailoring Salesmen: Selling Simpson's new $23.50 pure virgin wool suits, topcoats; commissions in advance; exclusive territory, big outfit 175 samples Free. J. B. Simpson, 843 Adams, Dept. 1454, Chicago, Ill.

Free Want Ad Catalogue No. 33, over 1,000 publications. Many combination offers. Publishers rates, place anywhere. Brinckerhoff, Inc., 37 W. Van Buren, Chicago, Ill.

Write for Free Samples. Introduce "Chieftain" Guaranteed Silk, Broadcloth, Work Shirts. No capital or experience needed Your Pay Daily. Monthly bonus extra. Cincinnati Shirt Co., Shop 2062, Cincinnati, O.

200,000 agents looking for something to sell. You can start mail order agents business in spare time. We spent lifetime learning how. Have just written correspondence course. Explains everything about starting your own business. Over 25,000 words boiled down to facts. Just send $1.00. We ship complete course C.O.D. for $2 98, postpaid. Money refunded if not satisfactory. We made good. Will you? Quinton, 365 Lincoln Place, Brooklyn, N. Y.

Men—South American work. Oil, Fruit, Rubber companies. Good pay. Expenses paid. South American Service Bureau, 14,600 Alma, Detroit, Mich.

Earn Money at Home, Full or Spare time. Oil Paint Photos. New Method. Easily Mastered. Highly Profitable. Oil Paint Outfit Free. Steady employment. Write, Free Book, Pictorial Art Studios, Inc., 2926 Broadway, Dept. S. M. C., Chicago.

Agents — Sensational Profits taking orders for Taylor made-to-measure, rain-proof caps and women's hats. $75 to $100 weekly. Commission in advance. We deliver outfit free. Taylor Cap Manufacturing Co. Desk E-10, Cincinnati, Ohio.

SCHOOLS

Home Study and Resident

Learn Piano by Ear in 90 days—Make money, be popular—No tiresome practice—No notes to learn. Write for Free Book. Illinois School of Music, 133 Hunter Building, Chicago, Ill.

Girls wanted for stage. Big pay. Learn stage dancing at home in spare time. Costs only a few cents a day. Write for free booklet. Veronine Vestoff, Studio B, 100 West 72nd Street, New York, N. Y.

Men 18 up. $1700-$2700 year. Ry. Postal Clerks. City Mail Carriers. Common education sufficient. Write immediately for full particulars. Franklin Inst., Dept. T90, Rochester, N Y.

Learn Electricity in Los Angeles. Technical practical training qualifies you for responsible position. School established 1905. Approved by electrical industry. 17,000 successful graduates. Free booklet. Nat'l Electrical School, 4006-AX, So. Figueroa, Los Angeles, Calif.

Men, become Forest Rangers; $125-$200 month and home furnished; permanent, hunt, fish, trap, etc. For details, write Norton, 270 Temple Court, Denver, Colo.

Woman—Care for invalid, fine homes your vicinity. $21 weekly if willing to take home training course in nursing. Winthrop Nurse Service, D6206 Winthrop, Chicago

Men qualify Forest Ranger Position; start $125 month; cabin and vacation. Patrol the forests; protect the game. Write Mokane, Dept. M-44, Denver, Colo.

Big Pay Jobs open in Automotive field. Learn how on real equipment with real shop tools in eight weeks. Satisfaction guaranteed. Write quick for special tuition offer including board and railroad fare. McSweeney Auto Schools, Dept. 21-B, Cleveland, O. and Cincinnati, O.

Men-Women, 18-50, qualify for Forest Ranger, Ry. Mail Clerk, Special Agents, other Govt. Positions, $140-$200 month; write Instruction Bureau, Dept. 137, St. Louis, Mo.

Earn $25 Weekly. Spare Time, Writing for Newspapers, Magazines; exp. unnecessary. Copyright Book "How to Write for Pay" Free! 1307 Press Institute, St. Louis, Mo.

Men—Get Railway Mail Clerk or Forest Ranger Job with Government; $125-$225 month. Permanent, short hours. Write Warren Inst., 500 Colorado Bldg., Denver, Colo.

We are in touch with the best and most reliable schools in America.

If you are interested in art, engineering, electricity, radio, aviation, or any kind of business training, we will help you find what you want. Please enclose 10c. *to cover cost of postage and receive advice of prominent school expert. Address School Dept., P.C.S., 9 East 46th St., New York.*

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ADVERTISE in 24 metropolitan dailies, 24 words, $15.00. Helpful Guide listing 1000 publications, 4c stamps. Wade Company, Baltimore Bldg., Chicago.

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ALL Advertisers should not be without the important facts on Money Making. Write today for the "Quick-Action Advertising Rate Folder" which contains information of value to you. If you are anxious for quick profit returns, do it now! Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

LETTERS, sales literature written. Long experience. Reasonable. O. Bartells, 504-52nd St., Milwaukee.

Authors, Song Poem Writers, Manuscripts

SONG Poem Writers—Send for proposition. Hibbeler, D10, 2104 N. Keystone Ave., Chicago.

SONG Poem Writers. Address, Monarch, 236 W. 55th, Dept. 126, New York.

WRITE Stories, Poems, Etc. Criticism, typing, marketing. Hursh Service, Dept. 3, Box 1013, Harrisburg, Pa.

I BUY, Sell, Publish Songs. Chester Escher, 12 Vroom St., Jersey City, N. J.

Aviation

THE American School of Aviation announces a new correspondence course in Mechanics of Aviation. A thorough training in Practical Aeronautics. American School of Aviation, Dept. 6741, 3601 Michigan Ave., Chicago, Illinois.

BIGGEST, Best Catalog Model Airplanes, Parts, Supplies; 5c postpaid. Ideal Company, 163½ Spring Street, New York.

SEND dime for 12 inch mounted propeller and circulars on free three foot model aeroplane. No selling. Aero Shop, 3050 Hurlbut Ave., Detroit, Mich.

BUILD your own Sport Monoplane. Blueprints and Instructions, $2.50. Allison Airplane Co., Lawrence, Kans.

AIRPLANE models, build and fly them. Our large catalogue illustrating 21 finest models, complete line of supplies sent postpaid for 10 cents. U. S. Model Aircraft Corp., 341-P-Monroe St., Brooklyn, N. Y.

LEARN Aviation. Complete courses flying taught by experienced men the year round at one of the oldest schools in the country. Learn aviation in all its branches or specialize. Applied Airplane Mechanics. Aerial Navigation. Airplane design and construction. Also a Home Study Course. Write for details of opportunity in 1928 for Aviators. Varney School of Flight. 1813 Main Street, Peoria, Illinois.

AVIATION'S Primer (Flying Instruction) 25c, Stamps 29c. Church, 1603 Golden Gate Ave., San Francisco.

HOME-STUDY course in Aviation, $15.00. Thorough, complete, including: Motors, Wings, Fuselage, Flying, Flight Theory, Drawings, Nomenclature, Repair, Maintenance, Manufacture Assembly Design, Meteorology, Navigation, and 50 other subjects. $18.00 on Time; $3.00 down, $3.00 weekly or monthly. Diploma given. Free Employment Service. Enroll now or write Romby National Aeronautical School. Dept. E, Box 43. Santa Monica, Calif.

BUILD and fly your own monoplane. 20-foot wing spread, 72 MPH with only 12 H. P. motor. Plans and working drawings complete, $10.00. Warner Co., 311 Edwards Bldg., Cincinnati, Ohio.

Bending Machines

THE Famous Hossfeld "Wrenchless" Universal Iron Bender is the last word in bending machines. Bends metal cold or hot into most any conceivable shape, including Eye Bolts and Automobile Spring Eyes. Bends up to 1" bars or 1½" pipe cold. Thousands in use by all classes of trade, from the smallest shops to the largest railway systems. Write for circular and prices. Hossfeld Mfg. Co., Winona, Minn.

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Blue Prints

TO THE man who has a Home Workshop and likes to work with tools, Popular Science Monthly offers the opportunity to purchase blue prints giving details of the construction of useful articles for the home. The following are a few of the blue prints available: No. 15, Workshop Bench, No. 17, Cedar and Mahogany Chest, No. 41, One-tube Radio Set, No. 42, Radio Receiver with three stages of amplification, No. 43, Four-tube Radio Receiver, 44 and 45, Model Pirate Ship, 46 and 47, Spanish Galleon, 48, Model Sailing Yacht, No. 50, Airplane model, 51, 52 and 53, Clipper Ship, 54 and 55, Five-tube Radio set. Send 25c for each blue print you wish to Popular Science Monthly, 242 Fourth Avenue, New York, N. Y.

Boats and Launches

BUILD your own boat. Outboard motor speedster, runabout, cruiser, row or sail using our knock-down materials. 55 Models. Send 25c for catalog. Brooks Boat Co., Inc., Salt Street, Saginaw W.S., Mich.

Books

A PERFECT Life $3.00—Write Art Card Co., Omaha, Nebr.

PRESS and public concede it to be the best ever produced. "Radio Theory and Operating," by Mary Texanna Loomis, member Institute of Radio Engineers, lecturer on radio, Loomis Radio College. Thorough text and reference book; 886 pages, 700 illustrations, price $3.50, postage paid. Used by Radio Schools, Technical Colleges, Universities, Dept. of Commerce, Gov't Schools and Engineers. At bookdealers, or sent on receipt check or money order. Loomis Publishing Company, Dept. E, 405 9th St., Washington, D. C.

ARTISTS—New Drawing Process and Catalog 10c. Artcraft Book Company, 2033-37 College, Indianapolis.

Rates 30 Cents a Word. A 10% discount is allowed on all contracts for six consecutive insertions. Advertisements intended for the April, 1928, issue should be received by February 5th.

Branch Office Services

BALTIMORE, Maryland, Address, $2.50 monthly, Daily Service, 341 Equitable Building.

Business Chances

FREE Circular. Sell little novelties by mail. Hadwil, 80A-74 Cortlandt Street, N. Y.

Business Opportunities

LEARN the collection business. Good income; quick results. Interesting booklet, "Skillful Collecting," free. National Collector's Association, Science Building, Newark, Ohio.

BECOME a Foot Correctionist. A New Profession not medical nor chiropody. All the trade you can attend to; many are making $3,000 to $10,000 yearly, easy terms for training by mail, no further capital needed or goods to buy, no agency or soliciting. Address Stephenson Laboratory, 10 Back Bay, Boston, Mass.

MINIATURE die-casting machines, $50.00. Byrd—318 Reed, Erie, Pa.

USED correspondence school courses sold on repurchase basis. Also rented and exchanged. Money-back guarantee. Catalog free. (Courses bought.) Lee Mountain, Pisgah, Alabama.

INVENTIONS commercialized. Patented or unpatented. Write Adam Fisher Mfg. Co., 183 Enright, St. Louis, Mo.

WE START you in business, furnishing everything. Men and women, opportunity to earn $35 to $100 weekly operating Ragsdale's original "New System Specialty Candy Factories" anywhere; wholesale or retail. Big commercial candy book free. W. Hillyer Ragsdale, Drawer 19, East Orange, N. J.

MR. ADVERTISER: Ask today for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Avenue, New York.

PRINT 250 signs or pictures an hour without press, type or machinery. Sample and particulars 10c. Sarteo, 1014, Springfield, Ohio.

ONE of the biggest mails on earth. Sent to any address for 10c. Louisiana Distributing Service, Dept. PMX, Harmon, La.

$50.00 WEEKLY, your own business. We furnish everything. Samples 10c. Whitney, Station C, Cincinnati, Ohio.

SUCCEED With Your Own Products. Make them yourself. Formulas, Processes, Trade-Secrets. All lines. Catalog, circulars free. C. Thaxly Co., Washington, D. C.

MIRRORS Resilvered at Home. Costs Less 5 cents per square foot; you charge 75 cents. Immense profits, plating autoparts, reflectors, tableware, stoves, refinishing metalware, etc., outfits furnished. Details Free, Write, Sprinkle, Plater, 94, Marion, Indiana.

CAPITAL. For copy of "The Promoters' Hand Book," a leaflet on financing, send $1.00 to Amster Leonard, East Orange, N. J.

FURCRAFT at Home. Positively the finest, surest and easiest big profits at home in spare time for men and women. Investigate now. N. W. Fur Co., Dept. 39, Omaha, Nebr.

THIS Advertisement may make you Thousands of Dollars, if you'll write immediately for my "Eye-Opening" Literature describing Guaranteed Formulas; Valuable Trade Processes, Money-Making Information how to easily make the World's Best-Selling Specialties. All lines. Investment Small. Profits Immense! Start in your Home, Room or Office. Make the Good Money you're entitled to. Dr. Liscombe Miller, Chemist, Tampa, Florida.

ADVERTISE—In 275 country newspapers; 28 words, $10.00. Lists free. Keator, Hartford Bldg., Chicago.

WANTED—Mechanical Leather Specialties to manufacture on royalty or outright purchase. F. Ranville Company, 241 Pearl Street, Grand Rapids, Michigan.

SELL by Mail!—Books, Novelties, Bargains! Large Profits! Particulars Free! C—Elfco, 525 South Dearborn, Chicago.

MONEY Making Book you are looking for. It may be your means of Financial Independence. Will send for only $1.00. Ellwood & Gerken, P. O. Box 204, Racine, Wis.

OPERATE chewing gum machines. Large profits. Small capital. Particulars free. Robbins Company, 28 Dodworth Street, Brooklyn, New York.

PATENTS procured; Trade Marks Registered—A comprehensive, experienced, prompt service for the protection and development of your ideas. Preliminary advice gladly furnished without charge. Booklet of information and form for disclosing idea free on request. Richard B. Owen, 44 Owen Bldg., Washington, D. C., or 41-Z Park Row, New York.

NEW System Mail Order Business, big profits, instructions FREE. King Company, Box 672-S, Wilmington, Delaware.

MEN wanting Mail Order work, send reply envelope. Coe, 129 East 59th St., New York.

Cartoonists

CARTOONISTS: Draw for slides. Either amateurs or professionals; write: Haines Art Studio, Box 244, Greenfield, Ohio.

Chalk Talks

LAUGH producing program, $1.00. Catalog free. Cartoonist Balda, Oshkosh, Wisconsin.

Dogs, Birds, Fish

BEAUTIFUL registered bull pups, $15. Bulldogs, 501 Rockwood, Dallas, Texas.

Duplicating Devices

STENCIL Duplicating Machine, (Post card size). Prints Illustrated Postcards, Blotters, Circulars, Etc. Complete outfit $10.50. Send $1.00 deposit, balance C.O.D. Your Money Immediately Refunded if not Satisfied. Keller Manufacturing Company, Pasadena, California.

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DON'T prepare for any Civil Service examination without seeing our free catalogue. Columbian Correspondence College, Washington, D. C.

"DOUBLE entry bookkeeping mastered in 60 hours with 8 keys; guaranteed; diploma." International Bookkeeping Institute, Desk 10, Springfield, Mo.

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GOVERNMENT pays big salaries. Prepare for next examination now. Expert coaching. Booklet free. Write L. Hampton. Box 1818-A1, Washington, D. C.

LABORATORY experts earn $300 to $500 monthly. Study microbiology, bacteriology, sanitation. Degrees granted, 71-piece outfit free. Free prospectus. Int. College of Microbiology, 722 Calumet Ave., Hammond, Ind.

STUDY Simplified Light Line Stenography or Bookkeeping, 25c. Squared-circle, Interest Problems, Free. Marr, Teacher, B605, Nashville, Tenn.

For Boys

"BOYS, Limited autographed edition Lindbergh's Book. Send advt. and $1. Gem Press, 236 Bailey, Los Angeles."

For Electricians and Helpers

THE Electrician's Wiring Manual, By F. E. Sengstock, E. E. Contains all the information needed for the proper installation of lighting and power systems in houses and other buildings. It completely covers inside electrical wiring and construction in accordance with the National Electric Code. Pocket size—flexible binding. 448 pp. Price $2.50. Popular Science Monthly, 250 Fourth Ave., New York City.

For Inventors

UNPATENTED Ideas Can be Sold. I tell you how and help you make the sale. Free particulars (Copyrighted). Write W. T. Greene, 805 Jenifer Building, Washington, D. C.

INVENTIONS Commercialized. Patented or unpatented. Write Adam Fisher Mfg. Co., 183 Enright, St. Louis, Mo.

I AM in touch with hundreds of moneyed men and manufacturers who wish to buy good inventions. Hartley, 38 Court St., Bangor, Maine.

INVENTORS' Universal Educator—contains 900 mechanical movements; 50 perpetual motions. Tells how to obtain and sell patents. Suggests new ideas. Explains how to select your attorney and avoid patent sharks. Special Price, $1.00 postpaid. Albert E. Dieterich, 681 Ouray Bldg., Washington, D. C.

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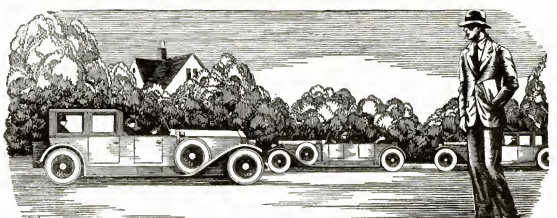

Many times in the old days while I trudged home after work to save carfare, I used to gaze curiously at the shining cars gliding by me, the prosperous men and women within. Little did I think that inside of a year, I too, would have my own car, a decent bank account, the good things of life that make it worth living.

I Thought Success Was For Others

Believe It Or Not, Just Twelve Months Ago I Was Next Thing To "Down-and-Out"

TODAY I'm sole owner of the fastest-growing Radio store in town. And I'm on good terms with my banker, too—not like the old days only a year ago, when often I didn't have one dollar to knock against another in my pocket. My wife and I live in the snuggest little home you ever saw, right in one of the best neighborhoods. And to think that a year ago I used to dodge the landlady when she came to collect the rent for the little bedroom I called "home!"

It all seems like a dream now, as I look back over the past twelve short months, and think how discouraged I was then, at the "end of a blind alley." I thought I never had had a good chance in my life, and I thought I never would have one. But it was waking up that I needed, and here's the story of how I got it.

I WAS a clerk working at the usual miserable salary such jobs pay. Somehow I'd never found any way to get into a line where I could make good money.

Other fellows seemed to find opportunities. But—much as I wanted the good things that go with success and a decent income—all the really well-paid vacancies I ever heard of seemed to be out of my line, to call for some kind of knowledge I didn't have.

And I wanted to get married. A fine situation, wasn't it? Mary would have agreed to try it—but it wouldn't have been fair to her.

Mary had told me, "You can't get ahead where you are. Why don't you get into another line of work, somewhere that you can advance?"

"That's fine, Mary," I replied, "but *what* line? I've always got my eyes open for a better job, but I never seem to hear of a really good job that I can handle." Mary didn't seem to be satisfied with the answer but I didn't know what else to tell her.

It was on the way home that night that I stopped off in the neighborhood drug store, where I overheard a scrap of conversation about myself, a few burning words that were the cause of the turning point in my life!

With a hot flush of shame I turned and left the store, and walked rapidly home. So that was what my neighbors—the people who knew me best—really thought of me!

"Bargain counter shiek—look how that suit fits," one fellow had said in a low voice. "Bet he hasn't got a dollar in those pockets." "Oh, it's just 'Useless' Anderson," said another. "He's got a wish-bone where his back-bone ought to be."

As I thought over the words in deep humiliation, a sudden thought made me catch my breath. Why had Mary been so dissatisfied with my answer that "I hadn't had a chance?" *Did Mary secretly think that too?* And after all, wasn't it *true* that I had a "wish-bone" where my back-bone ought to be? Wasn't that why I never had a "chance" to get ahead? It was true, only too true—and it had taken this cruel blow to my self-esteem to make me see it.

With a new determination I thumbed the pages of a magazine on the table, searching for an advertisement that I'd seen many times but passed up without thinking, an advertisement telling of big opportunities for trained men to succeed in the great new Radio field. With the advertisement was a coupon offering a big free book full of information. I sent the coupon in, and in a few days received a handsome 64-page book, printed in two colors, telling all about the opportunities in the Radio field and how a man can prepare quickly and easily at home to take advantage of these opportunities. I read the book carefully, and when I finished it I made my decision.

WHAT'S happened in the twelve months since that day, as I've already told you, seems almost like a dream to me now. For ten of those twelve months, *I've had a Radio business of my own!* At first, of course, I started it as a little proposition on the side, under the guidance of the National Radio Institute, the outfit that gave me my Radio training. It wasn't long before I was getting so much to do in the Radio line that I quit my measly little clerical job, and devoted my full time to my Radio business.

Since that time I've gone right on up, always under the watchful guidance of my friends at the National Radio Institute. They would have given me just as much help, too, if I had wanted to follow some other line of Radio besides building my own retail business—such as broadcasting, manufacturing, experimenting, sea operating, or any one of the score of lines they prepare you for. And to think that until that day I sent for their eye-opening book, I'd been wailing "I never had a chance!"

NOW I'm making real money. I drive a good looking car of my own. Mary and I don't own the house in full yet, but I've made a substantial down payment, and I'm not straining myself any to meet the installments.

Here's a real tip. You may not be as bad off as I was. But, think it over—are you satisfied? Are you making enough money, at work that you like? Would you sign a contract to stay where you are now for the next ten years, making the same money? If not, you'd better be *doing* something about it instead of drifting.

This new Radio game is a live-wire field of golden rewards. The work, in any of the 20 different lines of Radio, is fascinating, absorbing, well-paid. The National Radio Institute—oldest and largest Radio home-study school in the world—will train you inexpensively in your own home to know Radio from A to Z and to increase your earnings in the Radio field.

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Dear Mr. Smith:

Please send me your 64-page free book, printed in two colors, giving all information about the opportunities in Radio and how I can learn quickly and easily at home to take advantage of them. I understand this request places me under no obligation, and that no salesmen will call on me.

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Federal Schools Inc.

1355 Federal Schools Building
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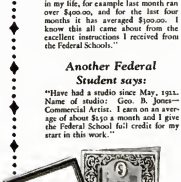

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Federal Schools, Inc.
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☐ YOUR FUTURE (drawing for advertising)
☐ A ROAD TO BIGGER THINGS (illustrating, cartooning, etc.)

Name .....
Age ..... Occupation ..... (Write your address plainly in margin)

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AMAZING New Glass Cleaner offers you $15 a day sure! Cleans windows, windshields, show cases, etc., without water, soap or chamois. No muss. Easily demonstrated. Housewives, motorists, garages, stores, institutions buy on sight. Write for Special Introductory Offer. Jiffy Glass Cleaner Co., 1655 Monmouth, Cincinnati, O.

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TELEGRAPHY—Both Morse and Wireless—taught thoroughly and quickly. Tremendous demand. Big salaries. Wonderful opportunities. Expenses low; chance to earn part. School established fifty years. Catalog free. Dodge's Institute, H374 Hart Ave., Valparaiso, Ind.

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SAVE Money. Make your own Tree, Grass, Weed Killer. Miller A. Agency, Kensett, Ark.

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DETECTIVES needed everywhere. Experience unnecessary. Particulars free. Write, American Detective System, 2190-P Broadway, N. Y.

WANTED—Live foreman or mechanic or clerk in every factory in the United States to act as subscription representative for the most popular magazine in the world. Address Manager of Representatives, Popular Science Monthly, 250 Fourth Ave., New York.

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Announcement to Manufacturers

With January Harpers Magazine starts,
for the benefit of American manufacturers:

THE COMMUNITY AND INDUSTRIAL BUREAU

In these days of high production and keen competition to dispose of this production at a profit, lower production costs are essential. Every manufacturer is searching out methods to lower costs of production and distribution for the benefit of his customers. The manufacturer in a large eastern city, for example, who discovers that he can secure a cheaper water power, a reliable labor supply and the raw materials he needs in a smaller city to the south or west, is able, if he changes his location, to deliver his product of the same or better quality, to the public at a lower price.

He thus increases his profits and adds to the economic wealth of the nation. Those manufacturers who are not bound by tradition of time or place are able, by careful analysis of markets to keep in the forefront of industrial progress. Harpers Community and Industrial Bureau will act as a clearing house of information for any manufacturer who is contemplating a change of locality in the interests of lower distribution and production costs.

It will be glad to put such manufacturers in touch with the proper authorities in other cities who are in a position to offer service and advice toward a solution of his problems.

Any manufacturer can write to this bureau in the full confidence that his name will not be revealed without his permission, and will be given through the services of this new bureau full information concerning the advantages offered for his particular business by cities, towns and localities in any part of the United States.

This bureau offers a similar service to individuals or families who, for health or climatic conditions, are considering either a permanent or temporary change of residence. Write to

Community and Industrial Bureau
HARPERS MAGAZINE
49 East 33rd Street New York City

Whistle-Punk

(Continued from page 42)

He found Herb just climbing into the tractor's cab. He got in beside him, and they started for the skidway.

"Well, mebbe this is the last day you'll be ridin' with me in the mornin'," Herb started off by saying.

"Why? Ye goin' to quit?" Emmet answered in a voice that was plainly lacking in interest.

"Think yer kiddin' me?" Herb spoke up sharply. "No, I ain't quittin'. We're havin' a meetin' tonight."

"Whut yuh havin' a meetin' fer?"

"You'll find out."

"How will I if I don't come?" The boy gave a sort of half-smile, partly defiant.

"You'll come all right, an' you'll tell what went on between you an' Old Codgy in the office last night."

EMMET looked at the tractor driver with something of amazement in his eyes. "But nothin' went on between us. Honest. Whut yuh think he said to me?"

"He was in the office long enough to say anything. That's up to you to tell tonight. You'll come and tell or git run out of camp."

Emmet turned his face toward the cab window. Finally he spoke: "Looky here, Herb, I ain't goin' to mix in on no meetin' with nobody. It ain't none of my business whut you do er whut the Old Boy does s'long's I git my pay."

"Yer pay!" Herb sneered. "Whistle-punk pay!"

"Well, it's honest pay, anyways."

"Say!" Herb shouted angrily. "Say, that's just about enough from you! You know what happened to the other punk? Well, the same thing'll happen to you, and won't be no accident!"

"Better look out, Herb," the boy smiled, and his voice was quiet, "or yuh'll be tellin' somethin' yuh don't want to."

Herb's eyes glinted black, evilly black. He darted quick glances at the boys.

"See that rock there stickin' out of the snow?" He hesitated and shoved up the gas throttle. The tractor leaped ahead. "Just to show you—what could happen if you was on top there on a—load of logs—"

His breath came quickly. Emmet instinctively caught hold of the side of the cab.

"—with a loose binder—"

THE tractor swerved and caught the rock sidewise. Emmet was knocked forward, his knees crashing into the dashboard. He felt a sharp pain. The tractor skidded, the motor roaring, and settled to one side, crashing against a beech tree by the side of the road. There were a couple of muffled explosions, and the motor died.

Emmet was on the down-side and had to wait until Herb had extricated himself from beneath the steering wheel before he could crawl out. His first thought was the book. He put his hand in between the buttons of his shirt and felt its smooth cloth-bound surface; then climbed out the cab window and faced the driver.

Herb stood beside the machine, nursing an injured arm, his face all of a greenish paleness, his anger completely burned out. He managed to say leeringly:

"That was just to show you what might happen if we was loaded and you was sittin' up on top of a couple thousand feet of loose logs." The blood mounted to his face again and, reassured by his own voice, added, "That was a Sunday School lesson fer whistle-punks that don't know enough to keep their blabbin' mouths shut."

Emmet looked at him with incredulous eyes. "Yuh gone and broke the tractor ag'in," he said.

* * *

The long bunk house was dim, even with the three hanging lamps (Continued on page 146)

Whistle-Punk

(Continued from page 144)

reflecting their light from tin shades and the big Rochester burner that was going full pelt by the barber's chair in one end.

The loggers sat around on benches or lay in their bunks—fretful, talking in several languages—most of them yawning and wishing the thing well over.

Herb was restless. One minute he would be brooding alone on a bench; the next talking heatedly to a swamper or roller in the other end of the bunk house. He was obviously dominating the scene, for none of them slept, although seven o'clock, their bedtime hour, had passed.

"More pay—McGuire's camp—five dollars," and a score more of words, pregnant with rebellion, rose clearly from Herb's throat among the babble.

The men were stirred up. The bunk house was electrified with jumping, vibrating emotions.

"DON'T know what's the use of waitin' fer that sneak of a whistle-punk any longer, anyways," Herb's voice came. "He wouldn't count after he got here, 'cept to show you fellers what's happenin' around here. A whistle-punk holdin' up the meetin'! I'll fix him right when I git hold of him."

The men's voices were hushed. The upturned eyes showed respect, and in some there was a kind of awed fear. For here was a man stronger than the Old Boy himself; who could make the Old Boy do as he said; who could get them high wages; a man who broke up a rector for no apparent reason, and could still tell the boss where to get off. Surely this *was* the boss.

"I wanted to git the punk here," Herb went on, "so's to show you how old Codger has been playin' us dirty. If that punk told all he knew, you fellers wouldn't stay around here and take all the kicks you've been gettin' and not make a peep about 'em. But I guess he's skairt after what happened this mornin'. I told him he had to come with our side or go with Old Codgy, so I s'pose he skipped camp."

An intense silence followed his words. He stopped to gloat over the effect. But the stillness was soon broken by the click of the door latch. Fifty pairs of eyes turned from Herb's face to the door, and fifty pairs of eyes widened in amazement. For in the door stood Emmet, the whistle-punk, smeared from head to foot with grease.

THERE was a shuffling of feet; an agonized undertone of a snicker; then the men set up a howl of laughter that made the bunk house ring. The tenseness that Herb had built fell clattering.

"Where've you been, Punk?" some one called. "Down in the oil barrel?"

A fresh burst of laughter rose.

Emmet grinned foolishly and slunk to a bench without replying. Herb glared at him.

"What you late for?" he demanded.

"Late?" the boy drawled. "I didn't know I was late. I jest et."

"Where you been?"

"Oh, under the tractor, monkeyin' 'round." Herb's face became darker. "Who said you could monkey around that tractor? Do you know who that tractor belongs to?"

"Belongs to the Old Boy, don't it? Er is it yours?"

Herb's voice quieted to a hoarse, throaty noise. "That's just a little matter 'tween you and me. We'll settle that later. Right now we might's well git down to the meetin'."

But the men were not ready for a meeting. There was still too much merriment to be had at the expense of the whistle-punk.

"What's the hurry, Herb? Let the punk, here, git the grease outa his ears so's he kin hear what it's all about," Kilts, the only shanty boy, spoke up.

(Continued on page 146)

Whistle-Punk

(*Continued from page 145*)

Herb was irritated, but he waited until the men could settle down to a serious state of mind. He pretended not to notice that the good humor the whistle-punk had caused had killed every word he had said; that the men were in no striking mood.

"Here, Dan, git the punk some hot water. He can't see the stove fer the grease in his eyes."

At each joke the men laughed more.

"What would yer mother say if she could see them dirty ears?" laughed old Kilts.

Emmet grinned back sheepishly, but never with a retort.

"Say, Herb," Callen, the timekeeper, said with quiet seriousness, "what would we do if the Old Boy come yellin' around here? What would he do if he caught us holdin' a meetin'?"

"He won't come around. He knows they's a meetin' all right, or it ain't my fault. He's settin' where it's nice and quiet in the cook-shack fer the evenin'," Herb mumbled with a sneer.

"Old Boy ain't yellin' around much anyways, these days," another said. "All the yellin' he does, he takes out on the punk."

LAUGHTER broke out again, but the tone was softer. And Herb broached the subject of the strike again with caution.

"You see how the Old Boy acts lately, have you? You see how he ain't yellin' around? If you knew what had been goin' on 'tween me and him, you'd know he has been keepin' so quiet. He's skairt, that's what he is. He knows McGuire is payin' a dollar more'n he is, and he knows he'll have to shut up er put up. He'll have to do hoth when we git through with him."

As Herb spoke, Emmet felt cautiously inside his shirt for the book concealed there. His eyes roved sleepily. His mind was not on anything that Herb was saying. The gibes did not touch him. He had found a way to the lower-turned tractor down the road. He was not even interested in the fate of the Old Boy, whose winter logging hung in a balance.

The book was safely secured inside his shirt and the tractor-path he would run again. That was all that mattered.

Herb was speaking on and on. The men had become silent. Here and there were nods of agreement. Herb had them with him again. The whistle-punk had become a nonentity.

HERB slowly worked his way to a standing position; he wormed over to the empty barber chair and put his feet on the lower rung. With pad and pencil, he figured as he talked, making a scale of wages for swampers, choppers, loaders, rollers and skidders; he even included the road monkeys.

As he talked Emmet's eyes became dreamier. He was tired. It had been a long day and a cold day. His hands had been exposed to the frosty pipes and inwards of the mysteriously fascinating tractor. He caught himself dropping off. Sleep—sleep—yuh gotta keep awake —or have that —Herb yellin'—gosh, it hurt—when a feller was—so sleepy. "Mebbe if I read a little. . . ."

He stirred and rubbed his eyes. He pulled out the book and opened it to a greasy page; but every page was greasy now. The whole book was thumbed and rethumbed with black smudges, and on many of the pages the corners were creased to mark important passages.

At last he came to a page that was not sooty and lent his head to the print. It was then that Herb's voice pricked through the mist of his thoughts. He heard the word "whistle-punk," and shot the book back inside his shirt.

"As to whistle-punk's salary," Herb's voice came leeringly, "mebbe the Punk oughta decide fer himself. What you say, Punk? Want Old Codgy to raise yer pay, or are you satisfied?"

(*Continued on page 147*)

Whistle-Punk

(Continued from page 146)

"Old Boy treats me all right," Emmet answered in a dreamy voice. "I ain't askin' fer no more pay till I kin earn it. Mebbe in a while now—"

His words were broken off by Herb's piercing voice:

"You hear, men?" he yelled. "You hear whut the punk says? Says he don't want no more pay. All right! Before we go further, now's the time to find out why he don't want no more pay."

Emmet was watching the wild lights that were coming into the driver's eyes. They looked as they had that morning when, in a frenzy, he had deliberately run into the rock. The men were eyeing him accusingly. The boy began to feel an uneasiness within him; his heart beat faster. In the silence that followed he could hear the blood pound in his ears. Herb went on:

"THE punk makes out he don't care nothin' about what's goin' on round here 'cept his readin'. That's jest one of Old Codgy's tricks—sneakin' 'round, pretendin' he don't know but what everything's all right. I'm jest tellin' you, that book business is the Old Man's doin's.

The boy's eyes grew large with incredulity. "He's tryin' to make out he ain't in with the Old Boy, spyin' on the rest of us all the time and tattlin'. Can't fool me. I seen his kind before. And if you all want to go on bein' fooled, all right. I'm through with yuh!"

The men showed their approval with a nod here and there.

"Now, we might as well start right in by findin' out what the Punk and the old man was talkin' over so long last night in the office." He stopped a moment, his red-rimmed eyes on Emmet. "Come on, punk, spit it out! Whut was you hatchin' up?"

Emmet stared at the big driver a full minute before he could reply. Finally, "Why, nothin'. Honest. We wasn't talkin' 'bout nothin'."

Herb took a step in the boy's direction. "Come on, now. Might just as well cough up, and it'll be that much easier."

"But, Herb," the boy's voice was almost quavering in its earnestness, "I don't remember a word he said. I was readin' most all the time."

"That's a lie!" the man shouted, and in three big strides was standing over the boy. He turned his head sidewise and spoke to the men again. "You see? Lyin' out of it! See him keep movin' his hand back and forth into his shirt and out ag'in?"

THE men had pressed forward and were forming a circle around the two. A cold dread clutched at Emmet's chest and held him breathless, while his hand, all unconsciously, worked nervously between the buttons of his shirt. His fingers were clenched on the book.

"See that hand?" Herb yelled again. "How do we know he ain't got a gun in there. How do we know the old man ain't bribed him to work that book stuff—all the time carryin' a gun, plannin' to kill some of us—"

His voice had reached the peak of its shrillness.

"Here! Le's see that there book, if that's all you got there!"

Emmet's face changed. He turned deadly pale, his dark eyes glowed with something of a white light.

"No!" he said between clenched teeth.

The muscles of his arm could be seen contracting underneath the cloth of his shirt as he clutched the book tighter.

Herb took a step nearer.

"Git away from me!" the boy cried in a voice strange to him, a voice suddenly hoarse.

"I'll give you three seconds to hand over that book or gun or whatever it is!" Herb snarled.

(Continued on page 158)

Whistle-Punk

(Continued from page 147)

The boy rose, his eyes wide and flaming. He was rigid, every muscle as taut as a fiddle gut.

"One—"

The men crowded closer.

"Two—"

Emmet met Herb's eyes unflinchingly.

"Three—"

Herb's big hand shot out and gripped Emmet's wrist in a vise, yanking it out of his shirt front. He grabbed the book in his free hand and wrenched it from the boy's rigid fingers.

What the men next saw were fluttering sheets of paper—pages and fragments of pages of the book as Herb ripped it to pieces, muttering the while. "Well—I'll—be—! So it—was—a book—"

His words were cut short. A lightning fist had caught the big driver's mouth, and Herb went reeling against the lumberjacks that surrounded him.

THEY caught him and held him up while he cleared his head. For a moment all was confusion. There was a milling about; a larger circle was cleared between the two—the driver and the whistle-punk.

Herb soon got his bearings. The whistle-punk stood ten feet away from him, his fists doubled, his body poised like an animal—lithe and sleek and crouching.

The driver made a lunge for the figure that faced him, but simultaneously that figure came alive, and they crashed with bone-splitting impact in the center of the ring. They broke instantly, Emmet wriggling away from the vise of Herb's arms.

Then he was at him again, his fists flying, pummeling at the driver's face and neck. Herb outweighed the boy by fifty pounds, but he was slow in comparison. His arms flailed the air awkwardly; his big boots seemed glued to the floor. He could not dodge the boy's lightning blows.

They clenched again, this time to Herb's advantage. With one arm locking the body of the boy, he pummeled him with the other. This time Emmet could not break away, but stood knotted while the driver's big fist hammered mercilessly.

They swayed. The boy felt the big man's foot between his legs; he felt a hold around his middle that was making things go black. His breath seemed to have stopped altogether.

He hit the floor with a thump, and the impact knocked him back to a point of reason.

What was happening? What was it all about? Yes, the book—his litterchure. He was on his feet again, and the swollen jaw of the big driver was before his eyes once more.

A HUNDRED voices were thundering in his ears, and above them all there was a voice vaguely familiar. He brought all of his energy into play again, and felt himself hurtling through space. His fist crashed against something hard. He felt himself falling; there was something warm and panting underneath him; no, it was over him. He struggled free again, only to be knocked back to the floor into what seemed to be a whirlpool of dancing lights.

"The book—he tore—yer book!—" some one was shouting in his ear.

Unseeing, he was on his feet once more, and a crouched form was coming at him slowly. He saw a red, protruding jaw. Needles of thoughts pierced his brain; he became a knot of fury, and his long right arm shot out once again. Again his fist made a contact with something hard; a pain shot through his arm.

There was a thud, sounding far off. The boy looked for the red approaching form, but could see only a blurred line of faces. He blinked his eyes like one awakening from a dream. The room was as still as a windless night. Then voices came to him, and the voice of the Old Boy rose above the rest. (Continued on page 149)

Whistle-Punk

(Continued from page 148)

"The kid ain't no whistle-punk. He's a fighter! Two of the cleanest knockouts I ever see!"

There were cries all about him. He felt himself being lifted bodily to a bunk. He struggled free from the arms that supported him, the mist before his eyes cleared, and on the floor before him he saw the body of Herb. But it didn't seem like Herb. It was all crumpled up, like something dead.

Then he saw the Old Boy.

For a moment neither of them spoke. The Old Boy's eyes were unsteady and watery. Finally Emmet found voice.

"Whut's the matter, Mr. Codgy?" Even his own voice sounded strange and far away.

"Ain't—nothin'," the Old Boy swallowed, "'cept ye showed me ye wasn't built fer no whistle-punk." He looked around at the men. "Whatta ye say, boys, think we better give him a new job?"

A CHEER went up from all sides. "Suppose ye could start work on the tractor in the mornin'? We'll be needin' a new driver."

"I started this afternoon, Mr. Codgy. It's runnin', too." There was something of a new alertness in his voice, something of pride.

The Old Boy gasped. "Well, I'll be ——"

At that moment a look of concern crossed the boy's eyes. "My litterchure!" he shouted and started to rise from the bunk.

"Stay where ye be, boy." The Old Boy put a hand on his shoulder. Then to the men, "Pick up them pages off the floor."

The boy looked down at the tattered fragments, and his voice came shakily—"My litterchure—all ripped to bits."

The Old Boy stooped over and picked up the cloth-bound cover of the book and squinted at the one-time gold-embossed title. A wide grin spread over his face.

"Why, this ain't litterchure, Emmet," he said.

"Well," the boy said falteringly, "that's whut they called it."

"Who called it?"

"Why, the place where I bought it." He looked up at the old man beseechingly. "I see it in the paper first. They was an ad that said: 'Send two-cent stamp, and we'll send yuh all the litterchure, free of charge.' And when it come they collected two dollars. But it was worth it."

The Old Boy was chuckling.

"Well, don't that beat the Dutch!" his fat jowls shook with merriment as he squinted again at the title. "I guess litterchure is what a man makes it. This here title reads, 'How to Be a Mechanic.'" He winked at the men.

"Well, it's litterchure, ain't it?" the boy persisted. "They said it was."

"Yes, it's litterchure in a way, I guess. It's history now, though."

It's a long way from searchlights to gyroscopes—but Elmer Sperry, one of America's greatest inventors, has both to his credit, and a host of other successful inventions besides. While most successful inventors specialize along rather restricted lines, this man's career offers remarkable demonstration of the versatility that can sometimes distinguish the constructive mind and temperament. Sperry is likely to turn his attention to almost anything. How he created the most dazzling beacon in the world and the marvelous spinning wheels that keep ships upright in the fiercest gales is an unparalleled story of triumph over obstacles in a thrilling battle between human wits and natural forces. Read of these feats and other highlights of the career that swamped him with honors and medals for scientific achievement in the March POPULAR SCIENCE MONTHLY.

Big Guns in France

(Continued from page 80)

shots on one of their proving grounds. If there was nothing better to do, we were always glad to demonstrate that there was no deception, so Battery No. 1 started to crawl to Nuisemont, a range near Chalons.

Well, a woman, a French woman, fired the first American-made shell from an American-made gun in France. The wife of a French physician in charge of a hospital near by pushed the magneto handle, rather scared because that gave her only one finger to put in one ear.

THE first shot fell at exactly 29,000 yards, and so did the third. The second fell at 29,300, and the fourth at 29,900. That was remarkably low dispersion, as all the French experts agreed. They had German prisoners go and search the landscape for shell fragments, and measure the craters. Then the Commandant came to me.

"*C'est magnifique,*" he said. "But waste no more shells here. Go and fire them at the Germans."

As he spoke, the French antiaircraft guns were firing, for the Germans seemed to be on our trail again and an observation plane was right overhead.

That was September 2, and that evening at a celebration dinner French and Americans outdid one another in predicting what would happen to the Germans when we actually reached the front. It was a great success, and the French Commandant led the orchestra. No, it wasn't that kind of party. He was an accomplished musician.

Quickly we started removing the gun from the pit and preparing to move to the front. At last orders came, and once more we launched our battleship on wheels. Out from the station came the *Chef de gare*, wild eyed.

"But Monsieur the Admiral," he cried, "I must go over your *ordre de transport.*"

An *ordre de transport* was supposed to be as necessary on a French military railroad as a ticket on an American. But we had had delays enough. I leaned out of the cab.

"Go and talk to Marshal Foch," I said. "He's the man I'm working for." Then I turned to the engineer and told him, "Let 'er go."

He forgot all about *ordres de transport*, hot boxes, six miles an hour—we were on our way to the front.

THE first shot we fired at the Germans was on September 6, 1918. Just one fourteen-inch shell weighing 1400 pounds.

No wonder that was a lucky shot. It was fired from the very spot at Rethondes, in the Forest of Compiègne, northeast of Paris, where two months later the Germans signed the Armistice in Marshal Foch's private car. That was the first of our early performances on the front that led the Marshal and General Pershing to give us a big part in the final battle that brought the Germans to Rethondes.

But our whimsical Fate followed us even then, for that first shot was fired by Gun Number 2 before Number 1 could reach the front after doing its stuff at the proving ground. Number 2's crew got in first after its crane car and pit equipment had been delayed reaching Rethondes, only to have the crane capsize with the transom bedplate. September 3 they got it back on the track, whereupon the crane base broke. September 5 pit and gun were ready, but too late to fire that day, and all hands were so dirty and mad that they went swimming in the Aisne.

Gun 2 was now under one of the fightingest French Generals, Mangin, who liked Americans and, like them, wanted to get at the Boche. Next morning he had an airplane to spot for us. The gun in its wooded lair was laid to a nicety on (Continued on page 151)

Big Guns in France

(Continued from page 150)

Tergnier, 41,000 yards away and, of course, invisible.

We waited and waited. No word from the aviator. Later we heard he had found visibility poor, run out of gasoline, and gone home. Lieut. E. D. Duckett, commanding the gun, got tired waiting.

"We'll never win a war this way," he said. "Let's fire off the map."

The French said he could fire one shot.

"Boo-oo-oo-oom!" said Gun 2, spurting a huge stream of fire and smoke, and slid smoothly back, like a serpent that has struck—sort of sea serpent, I guess.

Before we could fire again, the French called up.

"Cease firing," they said. "The Germans are leaving Tergnier. Our infantry are going in."

Just where that shot fell, I never knew, but soon afterward German airplanes were coming over to see where the earthquake had come from.

Now we really got into the war. Gun 2 went up to Fontenoy-Ambleny that night, and a wild night it was. The German airplanes dropped bombs that cut all the telephone wires, so the American train felt its way along with scouts ahead to see if the tracks were cut.

The sky was lighted by gun flashes, searchlights fingered the clouds for enemy airplanes, we heard the crash of shells, or the jarring explosion of bombs.

AT NINE o'clock the morning of September 7, the crew of Gun 2 broke ground for their new pit, whence they were to fire upon a big German ammunition dump in Besny-Loisy, just west of the city of Laon, principal railroad junction behind the famous Chemin des Dames front, and not far from the St. Gobain Forest whence the Berthas had shelled Paris. Even now, we were at the point on the whole western front nearest the French capital, from which ever more surely the Germans were being driven away.

It was fierce, hard fighting. Mangin had a lot of artillery and was hammering the Germans day and night. Only ten days before, he had made a great assault with the 32nd American Division, besides a lot of French troops. Now he was knocking the Germans off the Chemin des Dames ridge and out of Laon, breaking part of the famous Hindenburg Line. We were there to help, but before Gun 2 could fire from the new position, Gun 1, commanded by Lieutenant J. A. Martin, had run up alongside and at four o'clock the morning of September 10 we began to realize another ambition, to have something like a fleet of our battleships on wheels at the front together. Batteries 3, 4, and 5 and my staff train were being assembled at St. Nazaire, and five days later they had left for the reserve artillery base at Haussimont to be "on call" for any hot sector that needed them.

Speaking of hot sectors, the French had picked one for Gun 1. It was a cemetery, named St. Christophe, on the western edge of Soissons, where thousands of American tourists pass every summer. The Germans certainly tried to help fill that graveyard.

But as usual, on our land cruise, the Old Man of the Sea seemed to be following us across France, and he had to do a few tricks. When Gun 1 arrived at Fontenoy-Ambleny it was wrong end to. Now that wasn't as bad as the Army—I suspect some of those drug store ordinance experts—have tried to make out. The doughboys told the world the gobs brought their guns up to the front facing backwards, ready to fire on Paris. We knew that when we reached the front we would have to run the gun car up a "Y" track the French had for that very purpose, but some doughboy saw us doing it and

(Continued on page 152)

Big Guns in France

(Continued from page 151)

thus the story started. Now that it was early autumn, we had a good dose of "sunny France." It rained, or tried to, about every day, until Lieutenant Duckett got impatient again. The French had promised him another aviator, guaranteed to have a full gas tank, but on September 14 he hadn't shown up, so Gun 2 took a chance and fired ten shots at the German ammunition dump as best it could figure them out. Next day weather was better, the aviator appeared, and spotted for two shots in the morning. In the afternoon, the crew fired ten more shots based on his observation. Then came a message from the French.

"It's enough," they said. "*Fini*, ammunition dump."

Twenty-two American shells had blown thousands of German ones sky high.

THEY ordered Gun 2 to Flavy-le-Martel. Much to my surprise, they called me up sometime around the behind-the-front rush hour, say three in the morning.

"We can't find this place," they said. "We're where the map says it is, but it isn't."

"Break out hammocks and wait until morning," I said.

Around breakfast time, they called again.

"This place is it, after all," they said. "When it got light we found a sign that said 'Flavy-le-Martel.' But that's all there is above ground here."

It was true. Martel is French for hammer, and Flavy had been hammered into the earth by the terrific bombardments. Everyone there lived in dugouts. From this place, southeast of St. Quentin, Gun 2 fired thirty-five shells into Mortiers, an important railroad center north of Laon. Three days after the last of these, on October 16, the Germans left Mortiers.

This was part of the retreat in which they were gently assisted by Gun 1, which had a duel with the Germans and fired 199 of its great shells, two thirds of the 300 we thought any one gun could fire before going back for repair and relining.

For two weeks it was a one-sided duel. The crew of Gun 1 had to sit and take it. For instance, just as the moon (how we did hate her) came up the evening of September 23, one German plane ingeniously dropped three bombs on a French ammunition dump a few hundred yards from our gun, then four more on another dump still nearer. For five hours, those shells went on exploding, one after another, making the night hideous. "Rockets' red glare" and "bombs bursting in air," all right.

THE air seemed full of German planes, flying low, snooping around. Next night the same thing went on, but the Germans didn't hit a dump. The shelling of Soissons and its roads went merrily along, but on September 27 there was a bad sign. Just about breakfast time (nice fellows, those Germans) their shells started bursting over the gun. Fragments struck the gun car roof.

Gun 1 came back the next morning, September 28, by firing its first shots at the Germans. This began the bombardment that finally "sank" Laon, and a ticklish job it was. The city is on a hill, sort of a butte standing up out of the plain. Over behind the hill were the railroad yards and tracks coming into the city that the Germans were using for troop and supply movements. Our job was to blow up the yards and cut the tracks, without hitting the city, in which 7000 French people were still left of its before-the-war population.

Admiral Plunkett's and Mr. Johnson's inside story of the Navy's gun campaign will be concluded in the next number of POPULAR SCIENCE MONTHLY *with the thrilling narrative of the final crushing blows that made the Germans sue for peace.*

Answers to Sam Loyd Puzzles on Page 74

The Full Market Basket

In the old marketing days, according to Mrs. Miller's statement, she could have filled her basket and one third over for only two thirds of the cost of a full basket at present-day prices. Therefore, a full basket at the present time costs twice as much as in the days of yore.

She said that the old price of a full basket was five dollars less than today, and since that five dollars represents a reduction of fifty percent, the entire cost of a present-day basket must be ten dollars, as against five dollars in the old days. (Eight minutes.)

Building a Home

The paper hanger charged $200; the painter, $900; plumber, $800; electrician, $300; carpenter, $3,000, and the mason, $2,300. (Fifteen minutes.)

The Mysterious Letter A

The placing of the figure 1 before the professor's mysterious A, a number composed of five figures, obviously increases it by 100,000, so it then stands A plus 100,000.

The figure 1 placed after the mysterious A (its condition after A plus 100,000 has been multiplied by 3) is equivalent to multiplying it by 10 and adding 1.

Therefore, from the professor's demonstration, we deduce the equation: 3 times (A plus 100,000) equals 10 A plus 1, which solved, proves the value of A to be 42,857. (Ten minutes.)

The Spratt Family's Pork

Jack's capacity for lean pork is $^1/_8$ minus $^1/_{48}$, or $^1/_{10}$ of a barrel per week, so that he can eat the lean half of the barrel in five weeks. In that same time Mrs. Spratt will eat $^2/_{12}$ of a barrel of fat pork. At the end of five weeks, therefore, there will be left just $^1/_{12}$ of a barrel of fat, which will suffice Mr. and Mrs. Spratt for five days. Therefore, eating most expeditiously, it will require just forty days for the Spratts to dispose of the barrel of half fat and half lean pork. (Sixteen minutes.)

Rails and Acres

We find the rails to be of a very accommodating length, as it requires just 43,560 rails, just the number of square feet to an acre, or the number of linear feet on one side of the field. One rail cut into twelve pieces would build a three-rail fence around one square foot, therefore the answer is found as 1 is to 43,560. (Twelve minutes.)

A Puzzling Post Card

The message is decoded to read:

"Since you are three times richer than I, how much poorer am I than you?"

"Three times richer" is equivalent to "four times as rich," so if A's wealth is expressed by X, B's would be 4X. Also it might be said that A is seventy-five percent poorer than B. (Twenty minutes.)

Taking in a Partner

Henry's payment of $33,000 established the value of the firm's entire assets at $99,000. It was told that before the reorganization the senior's interest was one and one fifth times that of the junior's; so the senior must have owned $54,000 worth and the junior $45,000. To reduce these to a par with Uncle Henry's holding would require a payment of $21,000 to the senior and $12,000 to the junior, which just disposes of Henry's $33,000 in cash. (Ten minutes.)

Chances to Get Rich Never So Great

(Continued from page 30)

shortage would not be so easily met, for phosphorus is a rare element (in the relative scale), not merely an inaccessible one. Phosphorus would have to be manufactured out of some different element.

Such an idea was heretical thirty years ago. Then the atoms were supposed to be absolutely immutable. But today the simple—though still rather breath-taking—fact is that more than fifty elemental substances have been observed in transmutation in the laboratory.

In case of at least thirteen—perhaps twenty—of the lighter of these, the transmutation has been effected by a human experimenter.

The method originated with Sir Ernest Rutherford. It consists of the bombardment of a substance with alpha particles from a radioactive element. Individual protons, or hydrogen nuclei, are knocked from the nuclei of atoms of such elements as nitrogen, aluminum, silicon, phosphorus, sulphur, chlorine, and potassium. Only carbon and oxygen among all the more abundant light elements failed to yield, and their rupture has been reported in a German laboratory.

BUT, according to modern atomic theory, to remove a proton from the nucleus of a sulphur atom is equivalent to transforming that atom into an atom of phosphorus—unless, indeed, the alpha particle lodges in the nucleus from which it ejected the proton, in which case the sulphur atom becomes an atom of chlorine.

Photographs have shown such lodgment of an alpha particle in a bombarded nucleus—eight instances being recorded in pictures that show the paths of about 400,000 alpha particles!

Such a transaction would transform silicon, the world's second most abundant element, into phosphorus. Similar treatment would change argon (an inert gas of the air) into potassium.

It remains to bridge the gap between laboratory demonstration and commercial application. It is a task for the expert electrician—with superpower at command. Is this the billion-dollar opportunity you seek?

I suggested at the outset a coalition between the electrical forces of air and earth. Now I suggest a possible coalition between the air itself and radium.

The conception is based on the celebrated bombardment experiments of Sir Ernest Rutherford and the less known (and perhaps not fully authenticated) experiments in which the German, Dr. Gaschler, thinks he has shown that production of radium from uranium may be hastened by an electric current.

Rutherford's experiments show that nitrogen, the gas that makes up four fifths of the atmosphere, can be so bombarded with alpha particles from radium that hydrogen nuclei are driven from its nucleus—that is, hydrogen is produced from nitrogen.

THE cost of radium—around $3,000,000 an ounce—is largely due to the long and laborious process of isolating it, and if electric treatment can, indeed, hasten the production, no expense will be spared in producing the current—for a thousand uses might be found for the radium.

Here I suggest only its use as a perpetual source of alpha particles, for the bombardment of compressed air, that you might transmute nitrogen into hydrogen. Even a very small amount of hydrogen, thus produced, would unite explosively with the oxygen about it; and this ignition would cause the remaining nitrogen to unite with remaining oxygen, with further output of heat.

Thus a gas engine with air alone for fuel could fly an airplane round and round the globe till the engine itself was worn out.

If you can learn how to transform uranium quickly and easily into radium, you will be in line of a fortune.

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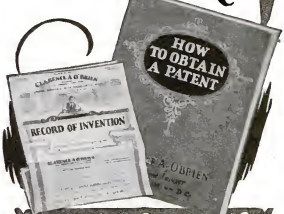

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Is Your Son Like You?

(*Continued from page 45*)

tion was in studying the heredity of individual characteristics that were sharply contrasted.

Mendel's first and simplest experiments give an idea of the way he reached his goal. He chose the common pea as his first object of study. He knew that some peas were tall, others dwarf; there were some with wrinkled skins, others with smooth; some were yellow, others green. Taking these contrasting characters one at a time, he set out to learn the effects of crossing the different varieties.

First he planted seeds of tall and dwarf plants, some several feet high, others a few inches. When these had grown into plants he fertilized the flowers of one variety with the pollen of the other. The seeds that resulted he planted the next year. When these grew up he found that the plants of the new generation, instead of being mixed varieties, as might have been expected, were all tall. Allowing these hybrids, or crossbreeds, to fertilize themselves in the ordinary way, he came upon another surprise—the seeds grew into mixed descendants, tall and dwarf, but in definite proportions of three talls to one dwarf.

FROM this Model concluded that the dwarf characteristic, unapparent in the first generation, merely had been held in suppression while the tallness alone appeared visible. Accordingly he termed the tall character *dominant* and the dwarf character *recessive*.

Now he continued the breeding to further generations, and this is what he found: The dwarfs in every case produced only dwarfs and continued to do so indefinitely. In other words, the recessives always bred true. One out of every three talls, or dominants, also bred true. The two remaining talls, however, always produced mixed offspring in the same proportion as did the original hybrids—three talls to one dwarf.

Repeating the same sort of crossbreeding with respect to other contrasting characteristics, such as color, Mendel found that in every case the same numerical arrangement held true. Even in the crossing of two or more contrasting characters, the law of averages still held, though revealed in greater complexity.

In all, he grew and studied 10,000 plants, performing nearly 300 cross-fertilizations, each requiring delicate operation. The vastness of his evidence enabled him, in the end, to substitute demonstrated fact for theory about heredity.

OF CHIEF importance was the fact that the Mendelian laws showed for the first time how pure breeds of plants or animals, possessing certain desired characteristics, might be obtained—a point of vital importance to breeders of cattle and horses and to farmers. But more than that, they led to a clear conception of the construction and operation of the cells of reproduction, and of the marvelous part which those little bodies within the cells, called chromosomes, play in controlling the character of coming generations.

Meanwhile, with the same vigor that he searched for scientific truths, he carried on the duties of his religion. Elected by fellow monks as abbot of the monastery, he fought tirelessly but vainly against oppression by government authorities.

Disappointments met him at every turn. In his greatest works, the world ignored him. Yet apparently he never lost faith either in scientific research or in his religion.

Indeed, his life was a concrete answer to those who said science and religion could not be reconciled. By patient observation and concentration he read the book of Nature's laws. And there he found new faith in a Law Giver.

"My time will soon come," said Gregor Mendel. It has.

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The Movie Maker

(Continued from page 16)

roller hacked away from the feet of the bridal couple, who had assumed as nearly as possible the positions of the dummies thrown from the car. For this scene, the flivver lay on its side in the hackground, as though tossed there hy the collision.

The final shots in that location were cranked hy the first camera man in normal speed and motion as the steam roller stolidy ambled away from the scene, leaving in its wake two flat shapes—stripes of cloth cut in the outline of the luckless couple. The camera was again stopped, bride and groom suhstituted for the cloth strips, and as the camera again began to crank, the couple rose, embraced each other, the groom manfully righted the automobile, and both rode merrily away.

"THIS will be a good comedy," Don prophesied, as the small caravan of cars turned toward Cinema City, on the northern outskirts of Hollywood.

"Hope Eckstein sees the rushes this afternoon," remarked Judy. "We've got thrills as well as laughs in today's shots. I can just hear the fans gasp when they see that roller crash the flivver. I'm anxious to see the rushes myself."

"We won't be back from the air field in time," Don reminded her, "hut there'll be plenty of excitement for us out there."

"It'll he a good way to celebrate after you see Eckstein this noon," Judy gaily suggested.

"Maybe—maybe not," Don replied. He was silent for the rest of the trip to the studio, hut Judy, glancing from time to time at the determined angle of his square, hig-boned chin, the compressed outline of his generous lips, and the tense frown that drew his brows together, knew he was suppressing with difficulty the excitement he felt for that all-important interview.

* * *

The president of Popular Players shrugged his shoulders and threw out his hands in a gesture of futility.

"But, Kennedy, I can't do nothing ahout it now. We close down *absolutely* for six months!"

"You mean—you mean—Popular Players is through? Smashed?"

"Did I say that?" demanded Eckstein somewhat irritably. "We keep our present releases going, hut make no new productions for six months—at least."

The young man across the desk from him looked stricken, his face so white that a few pale freckles showed across the hridge of his nose and in the hollows under his eyes. His stiff lips moved as though to make one last desperate plea, hut he rose with the words unspoken. The worried wrinkles in the president's face smoothed into kinder lines.

"Sorry, my boy. If you're not working when we start production again—maybe next March—you'll be the first director I sign on."

As Don vaguely mumbled polite thanks, there was a knock at the door and Porter put his head in.

"COME in, come in," called Eckstein, eager to close the interview with his disappointed youngest director. "I'm just telling young Kennedy here that we sign him on first when we get started again next spring."

"Sure, glad to have him." Ed Porter blew a noncommittal smoke ring toward the ceiling and added jovially: "That is, if he's not directing his own company hy that time. I hear he's working out an invention that'll cut production costs in half."

"Been telling me about it," chirped Eckstein, in a falsely cheerful tone. "Says he can show us a way to keep Carleton on the home lot with his cast and send only the camera man around the world to (Continued on page 159)

The Movie Maker

(Continued from page 158)

get all the local color backgrounds called for in any script."

"Yeah?" commented Porter with a yawn. "Guess it's too late for that now."

Suddenly, within the quiet, tall young man standing at the door, the gathering intensity of four long years of struggle toward a vanishing goal—night after night of grinding drudgery in a makeshift laboratory, the constant sacrifice of normal pleasures, decent clothes, and even, at times, of adequate food for his hungry young body that he might buy necessary equipment and materials for experimentation—all this accumulated force of keen desire and thwarted effort blazed out now in a white-hot rage at these two who ruled a realm with so little understanding and progress.

"TOO late!" he mocked. "You're right it's too late! Too late for Popular Players to make anything but another super-special failure! Day by day, in every way, bigger and better flops! Not enough brains in the company to spread thin over one reel of film, but all the footage any dumb director can throw away—two hundred reels squandered to make a ten-reel picture! Too late to pry any new ideas into this gang, but never too late to fail!" Don paused, gasping for breath, and then had the grace to be a little ashamed of his childish outburst, as the two men sat staring at him in dumb, open-mouthed amazement. Yet he felt a strange relief, as though a thunderstorm had cleared the air. Grinning, he walked back to the desk and held out his hand toward Eckstein

"Sorry, chief. I know the shutdown hits you, too. But, golly, I wish I could have just four months to show you what my universal background process can—"

"Say, I've got an idea," boomed the general manager. "Why don't you scout around, Kennedy, and see if you can't raise some money on your invention and form a production unit of your own? Eckstein knows your work well enough to release any picture you'd make on the usual sixty-five-thirty-five basis—"

"That's right," interrupted the president. "And instead of closing down completely," continued Porter, "we could lease you the lot at a nominal rental—"

"Oh, *very* nominal!" emphasized Eckstein.

"And you'd have a chance to cash in big on your own production and put your invention across at the same time," finished the general manager.

DON looked from one to the other with a wry smile.

"Fine! I've got eighteen dollars left from last week's pay. That would take care of about five minutes' time on the lease."

"Get some backers, boy. Get some backers!" urged Eckstein.

"I know hardly anyone in California but Popular Players people. 'Tisn't likely they'd invest in a new invention when they're losing their jobs."

"Tell you what I'll do!" Jacob Eckstein smiled expansively, as though to indicate the breadth of his generosity. "It'd be good policy to have some activity on the lot—I'll let you have it rent free for six months if you star Margaret Moreland and take over her contract."

In the silence that followed this big-hearted offer, the president of Popular Players exchanged a fleeting, guileless glance with his general manager. Its significance was not lost, however, on the young director. He was fully aware of the star's lost prestige and the causes for it, while the amount of her salary was common studio knowledge. Don knew that Eckstein's preposterous offer was merely a gesture, a covert insult to Margaret Moreland's faded glory (Continued on page 160).

The Movie Maker

(Continued from page 159)

and to his own intelligence. But suddenly the fighting blood leaped in his veins, his hands clenched. He looked steadily at Eckstein and his lieutenant.

"I'll take you for four months—September first to January first," he said briskly. "You can sign over Miss Moreland's contract with the studio lease under the conditions you mention."

DON paused on the doorstep of the administration building and gazed with speculative eyes over Cinema City. In less than a month he would control a considerable portion of that kingdom of make-believe.

It was noon—hot August noon—and after months of drenching sunshine, the celestial electrician had "hit" his giant carbon to highest amperage and was giving the land of the movies full flood. From the high unpainted wooden fence, where squatted rows of office buildings and laboratories, to the far sweep of ragged field rising toward the foothills, the vast acreage of Cinema City, jointly owned by several motion picture companies, was baked a dusty yellow-brown. Spreading out beyond the long, low concrete buildings, the awkward, high-hunched roofs of huge stage sheds loomed tinder dry. Farther still, edging the open lot, a Turkish minaret, the Woolworth Tower, and the Taj Mahal, grouped with lesser, lower scenes of commerce and grandeur, lifted their thin painted peaks to the blistering sun.

Don drew a deep breath, then lost it in a hearty, unexpected chuckle. His newly accepted financial responsibility was so stupendous compared with the minus quantity of his resources that, instead of appalling him, it appealed momentarily to his sense of humor. Later would come anxious planning, grim day and night drudgery, the strain and anguished struggle of accomplishing the apparently impossible within a short time limit; but now, in the brief pause before the battle, he felt an almost ridiculous sense of gaiety and reckless power—a zero-hour courage. Let the fight begin—he was ready, though he had no weapons but an unfinanced idea and a heavily-handicapped opportunity.

SWINGING his small suitcase, he walked rapidly toward the farthest stage, cutting across the current of a chattering, joking, hurrying populace that streamed from stage sheds, from cell-like rows of dressing-rooms, and from open sets on the lot. Grease-painted beauties in evening gowns, their eyelashes weighted with mascara. Thugs, policemen, tramps, and sleek-haired college boys jostling one another sociably. A director in swank leather puttees and open-collared tan silk shirt striding beside a tattered country lass with tangled hair, bare white legs, and smart high-heeled pumps. A satin-suited cavalier, flowing wig beneath his arm; two slimly beautiful bathing girls; electricians, carpenters, and stage-hand "grips" in stained khaki. And all with one objective—a square low building, centrally located, through whose wide-open windows floated the fragrance of fried onions, the rich tomato scent of chile con carne, the spiced aroma of hot tamales.

Don's long strides brought him to Stage No. 8 just as Judy came out and closed the door behind her. She pounced on him with a little shriek of joy, her face an animated question mark.

"Did Eckstein—he did, he did! You're smiling. No, you're only teasing—he didn't! Oh, don't be so mean!" Judy stamped her foot. "Why don't you *tell* me?"

"Give me a chance and I will," drawled Don with provoking slowness. Then, relenting, he outlined the interview in a few brief sentences. "So Eckstein's (Continued on page 161)

The Movie Maker

(Continued from page 160)

given me the lot to play with, just as you prophesied this morning," he concluded.

Judy's eyes, suspiciously bright, were fixed on an invisible circle she was tracing with the toe of one small brown riding boot.

"Lending you the lot without money to run it," she commented with mournful scorn, "is like handing a thirsty man the Pacific Ocean for a drink of water. Eckstein's giving you a buggy ride."

"Maybe." Don's lips came together in a firm line. "But we sign Monday."

"Where can *you* get any money?" Judy stared up gloomily.

"I'm looking for partners."

"Huh! Morgan and Rockefeller, I suppose."

"Not at all, not at all!" Don spoke with elaborate politeness. "I was thinking of extending the honor to you first."

"Me! What can I do?" Judy's voice was skeptical, but a lively interest began to show in the upturned corners of her mouth, in her brightening eyes.

"YOU own a corking story worth at least two thousand, don't you?"

"It's yours without asking!" Judy seized Don's hand in both of hers and pumped it up and down vigorously. "And I'll work for nothing. I've saved enough to keep me four months. When do we start?"

"This minute. You're on the payroll now. Nothing an hour and double that for overtime. But when the profits—"

"Attaboy!" Judy beamed up at him. "We'll show Eckstein!"

Don's only reply was a tightened handclasp and a brief nod.

"Better get your lunch now so you'll be ready to start for the air field," he warned, as he stepped into the stage shed. "I'm going to put my suitcase into that old property safe till tomorrow."

* * * *

The stars blinked faintly down upon the illuminated, richly colored square in front of Grauman's Egyptian Theatre, and Pharaoh's court, in hieroglyphics along the wall, waited for the jury to file out and render verdict on "Frozen Hearts." Lining the boulevard were Hollywood's choicest gasoline chariots, with here and there a liveried chauffeur. One of them began to whistle a fox trot as the doors of the theater swung open and the strains of the orchestra sounded louder and livelier.

IT WAS intermission. Beautiful women in gorgeous evening gowns and men in full dress began to trickle out; slowly, at first, then the court was suddenly dense with bright moving figures against an animated background of gleaming shirt fronts, blackcordered. Fire-brilliance of jewels on lovely arms and shoulders; perfumes drifting on the warm, still air; chattering voices, with a rumbling masculine undertone—an aviary of brilliant cockatoos, augmented by a flock of crows. In short, a first-night audience of picture people and fans.

But a little group of barnyard fowls stood at one side of the court, near the replica of an old Egyptian throne. Judy in a white silk sports dress, Don wearing a blue serge suit shiny at the seams. The third member of the group, a tall, lithe man with a ruggedly attractive, darkly tanned face, surveyed the human kaleidoscope with eyes half-gay, half-scornful.

"And you're asking me to give up flying to become a who's who in that bunch!" He laughed down at Judy with eyes as dark as her own.

"I'm not *asking* you!" Judy wrinkled her small and pertly tilted nose at her brother. "I'm just offering you a safe, easy job now that your plane is smashed."

"Oh, I'll have another next week," replied her brother airily.

(Continued on page 162)

The Movie Maker

(Continued from page 161)

"Jerry Burke!" Judy's eyes were accusing. "You promised me you'd quit the game if you had one more crash!"

"Come in with us for four months, anyway." Don added his persuasions to Judy's. "You're just the type to play opposite Miss Moreland, and I promise you plenty of excitement—helping us dig for money enough to keep celluloid in the cameras."

Jerry Burke did not answer, but tugged his small black mustache meditatively. Meditation was an unusual expression for the reckless gaiety of his face. The slight forward thrust of his fighting chin, the eagle strength of his aquiline nose, even the stubborn, careless waves of heavy dark hair, suggested a man of intense physical energy rather than calm thought. A smooth white scar slashed straight across from ear to forehead was a badge of action won in France.

BUT even before the war, Jerry had injected thrills into life. At the age of sixteen, a runaway from his New England home, he had learned expert horsemanship on a ranch in Montana. Then farther west, to California, where, a year before the war, he had doubled for a handsome motion picture star when dangerous stunts were required. This had paid so well that he had bought several acres of cheap, unirrigated land twenty miles from Los Angeles and had sent for his widowed mother and small sister. As part of the land extended into the mouth of a small canyon, he had fondly called it his "ranch," and was saving money to stock it with blooded horses when the war dogs called. He was one of the first to enlist. When he returned, three years later, he found that his "ranch" had become the peaceful locale of a small chicken farm operated by his mother. But by that time, horses had become too slow for Jerry and he threw his bounding energies into aviation, becoming a stunt pilot with a record for hair-breadth escapes. The last one had been only the day before, when he had crashed while stunting for the comedy Don was directing. He was glad he had deeded the ranch to Judy on their mother's death the year previous. The next crash might be tagged with his name and flowers.

BUT even danger can become monotonous, and as Jerry fingered his jaunty little mustache he felt half inclined, for a few months at least, to throw in his lot with the kids. He glanced at the two and realized with a start that Don could no longer be placed in that classification. He had been only nineteen when Judy had first brought him home to a Sunday chicken dinner—and how the tall ungainly lad had eaten!—but the five years since then had changed the boy into a serious, almost stern-faced man, still young, of course, but with the dignity of a steady, driving purpose. At that moment, Don and Judy were looking with eager interest toward the theater entrance.

Jerry's glance followed theirs and rested on a slender, exquisitely-blond woman who had just come out, her fairness enhanced by a low-cut gown of black velvet. Over her shoulders was flung an ermine cape. Pausing at the entrance as though to brace herself against an oncoming tide, she lifted her small head regally. The tide swirled toward her and Margaret Moreland was submerged in a wave of congratulations. As the crowd shifted, Jerry noticed a vivacious brunette peck her on the cheek and utter a delighted little shriek.

"My *dear!* You were *marvelous!* Greatest picture of your career!"

Margaret Moreland's response was lost in the babel of voices, but Judy's eyes sparkled with anger as she pressed nearer the entrance.

"Cat! I just (Continued on page 163)

The Movie Maker

(*Continued from page 162*)

heard her say they ought 've named the picture 'Frozen Face' in honor of Moreland!"

Jerry chuckled and pinched his sister's arm.

"Who is the lady Judas?"

"Rita D'Arcy, Queen of the Vamps. She always has it in for blondes. Come on—there go the chimes—let's get to our seats before the mob comes in."

As they passed Margaret Moreland and her courtiers, whose flatteries were merely veiled insults, Jerry turned for a long, curious look at her. He was not a devotee of the pictures, caring more for outdoor amusements, but he had seen the star in the great Biblical spectacle that had scored such a triumph for her three years before. From across the court she had looked singularly lovely, with her delicate, high-bred features and the great coils of shining hair massed at her neck. But now, under her wide blue eyes, he noticed dark circles that no amount of cleverly applied make-up could conceal; the taut muscles of her neck, her cheeks, inclined to sag, and the fixed smile that drew her tired lips into a painted grimace.

"I DON'T like the glitter in that gal's eyes," he murmured to his sister as they entered the theater. "Does she use dope, d'you think?"

"Oh, *no!*" Judy was very positive. "She's an awfully sweet thing—never any scandal about her—but she's had lots of bangs the past two years. And when her good-for-nothing husband ran off with that flashy divorcee, it must have been a terrible blow to her pride."

"Perhaps she loved him," suggested Jerry.

"Whatever it was, she began to go off in her looks and she's never come back since. I don't know how Don's ever going to put her across in a picture," Judy added in a discouraged whisper as they took their seats, "even if he can scrape up enough money to pay her salary."

"Cheer up, infant. I'm coming to the rescue."

"Oh, Jerry! Really?" Judy's eyes shone in the semidarkness of the theater as her brother gave a confirming nod. She turned to Don, at her other side. "Don! Jerry's coming in with us! Tell the professor."

"Good!" Relief and hearty satisfaction were compressed into the word as Don leaned forward and the two men signed the contract in a firm handclasp with Judy smiling her blessing between.

Immediately, Don turned to an elderly man on his left and murmured the news.

"DAS is gut!" approved Professor Mahrlenburg in a husky whisper. Although he ordinarily spoke perfect, almost unaccented English, when under emotional stress he reverted to his native tongue. He had been polishing the thick lenses of his spectacles and now he adjusted them carefully before his eyes as the curtain parted and the silver screen announced: Frozen Hearts, Part Two.

As the light on the screen threw back a faint reflection into the faces of the audience, Don caught a glimpse of the old German's faded blue eyes, red-rimmed. That confirmed Don's suspicion that he had been crying throughout the first part of the picture, as evidenced by frequent polishing of his glasses. At the intermission, when the other three had gone outside, Professor Mahrlenburg had declined, mumbling some excuse about reading his program carefully.

What was the matter with the old fellow? In the darkened theater, only half observing the picture he had seen at a preliminary showing, Don sought a clue to this new difficulty. In addition to the personal concern he felt for the old man, he was counting on him as a valuable asset in his new venture.

Professor Mahrlenburg had given Don his first job in California five years before in a cheap little photographic

(*Continued on page 164*)

The Movie Maker

(Continued from page 163)

gallery at a seaside resort near Los Angeles. At that time, the old man had been violently opposed to motion pictures, and when at the end of the summer Don had proudly announced his new job in the laboratory of Popular Players, the professor, almost apoplectic with anger, had literally closed his doors on the boy. Two years later, however, Don had met him, hungry and shabby, coming out of a small neighborhood picture theater in a cheap district. The picture chanced to be one of Margaret Moreland's old releases, and from that time the professor had been an ardent Moreland fan. Don had taken him home to share his humble lodgings and at first had been glad to see that the old man's prejudice against the pictures had disappeared, but during the past year his violent partisanship of Margaret Moreland had amounted almost to an obsession. Only the night before, when Don had referred to her look of age, he had shouted out a denial, claiming that Miss Moreland was only twenty-eight, and giving date and day of her birth. For a year, the old man had been working mysteriously on a series of fine lens screens and other paraphernalia designed to make the star appear a girl of eighteen. He had vowed he would allow them to be used for no other actress.

A QUICKLY subdued titter rippled over the audience, for at that moment a close-up appeared on the screen. Margaret, as a young Russian princess, leaned from a balcony window to wave farewell to her lover—and as the unsparing lens pitilessly revealed the sagging lines and hollows of her face, she looked old enough to be the young man's mother. That, added to a saccharine subtitle, was enough to start a slightly hysterical giggle in an audience whose nerves were never well controlled.

At Don's side, the professor began to mutter angrily in German. Several people looked around, annoyed and amused. Infuriated, the old man half rose from his seat and directed fluent German maledictions toward any face turned in his direction.

It seemed to Don that the entire audience craned their necks toward him. An usher hastened down the aisle. Grasping the old man by the arm, Don turned to Judy, but she and her brother were already preparing to leave.

Don towed the professor, still muttering, up the aisle and out of the theater. In the lighted court his florid face looked lobster-red.

THEY got him into the tonneau of Jerry's ancient Pierce-Arrow, a topless vehicle parked in the thick of Hollywood's finest. But the car gave all that Jerry asked—speed. As he began to maneuver out of the line, he stopped a moment to watch a blond woman in ermine cape run swiftly, almost furtively, through the empty court and out on to the boulevard, where she hesitated a moment, glancing round, then sped toward a shining, long-bodied sport roadster parked at the opposite curb. The idling chauffeurs looked at her curiously; one ran after her, as if to offer aid. But she waved him away and jumped into the car.

Jerry turned and called his sister's attention to the woman. Judy looked up from the professor, whom she and Don were attempting to calm.

"Yes, it's Margaret. Ducking that bunch of laughing hyenas after the theater."

As the glittering roadster pulled out from the curb, the old Pierce-Arrow nosed after her discreetly.

"Think I'll follow her for a bit," Jerry announced to the three in the back.

"Don't!" urged his sister. "Let the poor thing hide her head in peace."

"No. Told you her eyes look queer. I've seen shell-shocked (Continued on page 165)

The Movie Maker

(*Continued from page 164*)

men with eyes like that when they're dangerous. She needs a guardian tonight—and quick!"

Judy sank back into her seat, and Jerry gave all his attention to the road and the car ahead. A big, cream-colored roadster, with high hood, bullet shaped, it was easy to follow—easy if you had the speed. As Hollywood dropped behind and the long shaft of light ahead began to ascend the hills, Jerry felt the accelerator of his own car grow hot beneath his toe.

Forty-five, fifty, fifty-five miles—a dangerous speed along those dark, winding roads. Fortunately, after getting well out of Hollywood and high on the hills, they met no other cars. The reason was apparent when the road became suddenly rough. For a moment, Jerry thought the big, racing roadster would bounce over the side of the hill, almost a precipice at that height. Only a flimsy whitewashed fence protected the unwary motorist. But Margaret, with a skill that delighted Jerry even while he caught his breath, held her car to the road as she throttled down. A moment later she drew off to the side where the road, cut into the hill, widened for turning. She stopped.

JERRY drove past her at a moderate pace, faintly tooting his horn as a passing salute. She gave no answering honk but sat still and rigid at the wheel.

She had come to a stop near the crest of the hill. Jerry increased his speed until he had rounded the next descending curve, then scraped close to the side of the hill and shut off his engine, leaving his lights on.

"I'm going back to reconnoiter," he said. "You folks wait here."

He spoke in a whisper, though the girl they had passed could hardly have heard a stentorian tone. But only a whisper seemed fitting in the hushed enchantment of the night, without sign or sound of human beings save themselves. In the east, the big golden disk of a full moon was rising, and the canyon dropped away at their feet like a bottomless black ocean. Long ghost fingers of pale moonlight poked into the fringing shadows of the road.

"I go—I go also to mein liebes kind." Trembling, Professor Mahrlenburg climbed out on the road beside Jerry, in spite of Don's restraining hands.

Jerry turned on him sternly.

"Do you want to kill her?"

The old man groaned and covered his face with shaking hands.

"STAY here," whispered Jerry in a kinder tone. "Maybe she's come out only to be alone, where she can get hold of herself. If she seems all right, I'll come back and get the car. We can pass her again and speak to her—pretend we think she's having motor trouble."

"No, Jerry." It was his sister who spoke. They were all in the road now. "We'll follow you at a distance, quietly. You go ahead as fast as possible. Don't waste time talking."

In silence the little group started back over the hill. Jerry was soon lost in the dark, for the other two young people accommodated their steps to the professor, who was breathing heavily as he made the ascent.

The climb seemed endless to Don. His muscles strained to be speeding after Jerry, but he could not leave Judy alone to cope with the professor. As he half carried the old man up the road, Judy preceding them a few paces, it seemed a nightmare climax to a day of calamities. The vice president of the bank that handled his small checking account had told him courteously that morning it would be useless to apply for a production loan without the backing and guarantee of Popular Players. In going over the features that his lease and contract should cover,

(*Continued on page 166*)

The Movie Maker

(Continued from page 165)

Eckstein had insisted on the insertion of a phrase that practically nullified his promise to release the finished picture through his chain of theaters. The third obstacle had come that night when he had heard that Margaret Moreland had been affronted by Eckstein's suggestion to sign her contract over to his comedy director and was threatening legal action.

Was the whole project to die at its birth? Although it offered only the slightest chance of success against tremendous odds, Don felt sure that without this one opportunity, he would have to begin all over and wait perhaps for years before he again drew near enough even to sight his goal. Was life to be only an endlessly steep, dark road over which he must toil to drag a heavy burden?

With a final tug, half lifting, half pushing, Don got Professor Mahrlenburg up the last rise in the road, just as Judy stepped back into the shadows with a quick-drawn breath.

A FEW yards away Margaret Moreland stood beyond the whitewashed fence on the very edge of the declivity. The bright moon shone coldly on her rigid form, a shadow in the black velvet gown. But her clear, fine profile seemed to float luminous and detached above her body, the sweeping line of her white throat, her thick-coiled hair of pale gold cutting the darkness with a cameo line. She stood with head thrown back, as though taking a last look over the world.

Slowly, almost mechanically, she raised her right arm. Steel gleamed in the moonlight.

As Don sprang forward, a black shadow leaped up from the edge of the road and flung itself on Margaret.

A shot and a gasping breath—a tiny spurt of flame. Two writhing figures struggled, swayed—and plunged forward as the fence tore loose with the cracking sound of a giant match stick snapped in two.

A breathless moment, in which tragedy moves to engulf the men and women in a real-life drama more thrilling than the screen itself! Then a voice, Cleveland—the further adventures of Don Kennedy in his daring fight for success against tremendous odds—these remain to be revealed in next month's great installment.

Ants Have "Cowboys"

NOT only do the ants keep herds of "cows" to supply them with milk, but they employ ant "cowboys" to watch over the herds!

This astonishing discovery was reported recently by H. Eidmann, a naturalist of Munich. Within ant colonies he actually found dairy "barns," into which the "cows" are driven at night.

The "cows" of the ants, as observers long have known, belong to the insect species called aphids. A sweetish liquid which they excrete is the "milk" which the ants drink.

The insect "cowboys" act much like human herdsmen. In cold seasons they drive the "cows" into the "barns" at night, turning them out during the day to feed on vegetation. Throughout the summer the herds remain outdoors, constantly guarded by the herdsmen.

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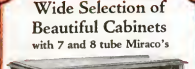

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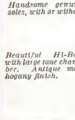

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Whether interested in the Miraco—8 (above pictured), the Miraco—7 or the Super-Six at $36.75 retail, save or make much money on sets and battery or electric equipment by writing for testimony of nearby users and *Amazing Special Factory Offer. Miraco's work equally fine with batteries or "AC" Electric house current equipment direct from light socket.* Take your choice. Many thousands of Miraco users—who bought after thorough 30-day comparisons—enjoy programs Coast to Coast, Canada to Mexico, good and clear—with magnificent cathedral tone quality.

Do not confuse Miraco's with cheap radios. Miraco's are powerful, super-selective, magnificently toned radios—built with finest parts, latest approved shielding, metal chassis, etc., as used in many $200 sets.

Deal Direct with Big Factory

Your Miraco reaches you completely assembled, rigidly tested, splendidly packed. Easy to connect and operate. Try it a *full* 30 days in your home. 3-year guarantee if you buy.

You take no risk, you insure satisfaction, you enjoy *rock-bottom money-saving prices* by dealing direct with one of radio's oldest, most successful builders of fine sets. 8th successful year in the manufacture of fine radios.

Write for Amazing Special Offer

Special wholesale prices to users who will show the Miraco to friends. An easy way to get your set free and make extra money. Write for *Amazing Special offer.* Mail Coupon or postal now!

Dealers Write!

Free!

Send for Beautifully Illustrated Catalog and Amazing Special Offer

*MIDWEST RADIO CORPORATION
408-J MIRACO BUILDING CINCINNATI, OHIO

MIDWEST RADIO CORPORATION
Pioneer Builders of Sets
408-J Miraco Building, Cincinnati, Ohio

Without obligation, send free catalog, 30 DAYS' TRIAL, AMAZING SPECIAL OFFER, testimony of nearby Miraco users.

☐User ☐Agent ☐Dealer

NAME_____

ADDRESS_____

THIS COUPON IS NOT AN ORDER

*Special Wholesale Price Offer to User-Agents. Bank References—testimony of nearby Miraco users—all the proof you want—sent with catalog.

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

The Crosley A C Bandbox is the leading radio of today—*because*

At last! The radio tube that needs no batteries! Here it is functioning quietly, smoothly, powerfully in this new Crosley 6-tube receiver—the A C Bandbox.

Now, the Crosley A C Bandbox needs no more attention than you pay the electric lamp that lights your home.

This is what the world has anticipated and many have imitated. Crosley offers it to you at the WORLD'S LOWEST PRICE—$110 without tubes.

Combined with the Crosley facilities for economical manufacture is the patent situation of which Crosley has full advantage. Licensed to manufacture under the patents controlled by the electrical and radio industries, the Crosley Bandbox is a NEW receiver incorporating latest radio developments, the most advanced ideas of radio reception as well as sound reproduction. This outstanding engineering job is best understood when you consider its features are such as are found in radios twice and more its price.

1. Compare shielding of all elements.
2. Absolute balance (genuine Neutrodyne).
3. Volume control
4. Acuminators for sharpest tuning.
5. Single cable connections.
6. Single station selector.
7. Illuminated dial
8. Adaptability to ANY type installation.

The set is solidly mounted on a stout steel chassis. As all controls are assembled together in the front, cabinet panels are easily cut to allow their protrusion. The metal escutcheon is screwed on over the shafts and the installation has all the appearance of being built to order.

Two large furniture manufacturers have designed console cabinets in which the Bandbox can be superbly installed. (Showers Bros. Co., of Bloomington, Ind., and the Wolf Mfg. Industries of Kokomo, Ind.) Powel Crosley, Jr., has approved them mechanically and acoustically and has seen to it that the famous Crosley Musicones are built in them so that the best type of loud speaker reproduction may be insured.

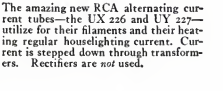
The Bandbox is housed in a brown frosted crystalline finished metal case which is easily removed for console installation.

See the new Crosley A C Bandbox at your dealer's NOW! Hear first hand its delightful performance! Enjoy the best in radio at the least cost! Write Dept. 17, if you can't locate a dealer!

of these wonderful tubes

The amazing new RCA alternating current tubes—the UX 226 and UY 227—utilize for their filaments and their heating regular houselighting current. Current is stepped down through transformers. Rectifiers are *not* used.

the radio patents of these industries



The research and development work of these great industries—The Radio Corporation of America, The General Electric Co., The Westinghouse Co., The American Telephone & Telegraph Co., and The Hazeltine and Latour Corporations—are available to Crosley engineers in the constant advancement of radio design.

and the amazing capacity of this MERSHON *Electrolytic* CONDENSER

This is one of Crosley's great features. It is an exclusive Crosley device. It is self-healing—will last indefinitely—never needs attention and eliminates the danger of blown out paper condensers which are causing so much trouble in electrically operated sets.

CROSLEY RADIO

Crosley is licensed only for Radio Amateur, Experimental and Broadcast Reception.

The Crosley Radio Corporation
Powel Crosley, Jr., Pres.
Cincinnati, Ohio

Montana, Wyoming, Colorado, New Mexico and west, prices slightly higher

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

R. R. DONNELLEY & SONS CO., CHICAGO

From a painting, © by Gerrit A. Beneker

Julien Charles Tournier

In the life program of Julien Charles Tournier, public recognition had no part.

He began as an instrument maker in Edison's laboratory. His forty-five years of service to electricity were completed in the same work, at the Schenectady plant of the General Electric Company.

He invented and contributed improvements to switches, sockets, fuse-plugs, and attachment plugs. He might have retired, had he so chosen, and lived in comfort; but his love for electricity was his life, and he was content.

We publish his picture as a tribute to him and because he typified the thousands of men and women who have dedicated their lives to electrical development.

The world will never know their names. They have no craving to be known. But their devotion is something quite beyond the interest of men in ordinary business. They deal with a power of vast usefulness.

Within the ranks of the General Electric Company are many such men. Their spirit is the best assurance that electricity will year by year find more and better ways to serve.

GENERAL ELECTRIC

No More Razor Blades To Buy!

365 KEEN SHAVES
A YEAR WITH ONE SINGLE BLADE

"I want to say that KRISS-KROSS Stropper is the best thing I ever saw. I have been using one blade continuously for one year and nine months and have no idea how much longer it will last."
C. S. STEPHENSON, Okla.

Inventor Discovers Amazing New Way to Shave! *—Without Buying Blades!*

KEEN, velvety shaves forever and no more blades to buy! That's what the astonishing invention of a St. Louis man offers the great army of American shavers today!

KRISS-KROSS is destined to revolutionize all existing traditions of shaving! Its performance is so sensational that it seems hardly fair to call it a stropper. Rather it is a *super*-stropper or blade-rejuvenator! Almost literally it makes a new blade out of an old one every day. No longer do you find that your blades "die" after five or six shaves. KRISS-KROSS "brings 'em to life" a surprising way, week after week and month after month—and endows them with a keenness that they never possessed when *brand-new!* Actually—you can take a blade right out of a fresh package and improve it as much as 100% in eleven seconds with KRISS-KROSS! No wonder experts pronounce it one of the greatest inventions ever patented!

Magic Diagonal Stroke

Until you've seen KRISS-KROSS, fitted its sturdy, nickeled smoothness into the palm of your hand and tested its uncanny dexterity *yourself*, you'll never know how amazing it really is!

It employs the famous *diagonal stroke*, same as a master barber uses. Never before has anyone captured the secret of reproducing it automatically. Eight "lucky leather grooves" do the trick in 11 seconds with a precision it takes a master barber years to attain.

But that's not all, KRISS-KROSS embodies still another feature that has hitherto baffled mechanical reproduction. It strops from *heavy* to *light*. It's absolutely uncanny the way the strokes start with strong pressure and grow lighter and lighter until an adjustable, automatic jig flies up and notifies you that your blade is ready—*ready with the keenest cutting-edge that steel can take!*

Fits All Makes of Blades

KRISS-KROSS produces unbelievable sharpness and prolongs the life of any razor blade for months and even years. Fits all brands and makes except Durham. Eliminates 83⅓ of shaving costs. No more "raking" and scraping with dull blades. No more stinging and smarting that has to be relieved with messy lotions and harsh astringents. KRISS-KROSS solves your blade problem for all time and gives you keen, velvet-smooth shaves forever!

Mystery Razor FREE

Sensational Offer

And now for my surprising offer. To introduce KRISS-KROSS, I am giving with it Free a new kind of razor. Possesses remarkable features. Instantly adjustable to any shaving position. A flip of the finger makes it (1) T-Shape; (2) straight (old style); (3) or diagonal (new way). Gives a *stiffer* instead of *jointy* stroke. Simply slips right through the toughest crop of whiskers. Made of purest metal. Comes with 5 special-process blades and is entirely unlike anything you ever saw before!

Get Free Offer

Send for full information on these surprising new inventions today. KRISS-KROSS products are never sold in stores. You deal direct with me or my authorized representative. Write for illustrated description and full details of free razor offer. It's even more remarkable than I can tell you in this short space. Clip the coupon now. Mail it today.

AGENTS $30 A DAY AND UP

Make big money with KRISS-KROSS. Giving away FREE razors boosts your profits amazingly. H. King made $66 in one day. N. C. Paige made $101 in 3 days! Others average $350 and up to $750 a month! *Spare-time* workers, *Office* and *Factory* men make $6-$12 extra a day showing KRISS-KROSS to friends and fellow employes. S. Kantala made $154 extra just working evenings 3 weeks. Get details at once. Check bottom of coupon and mail it tonight!

Rhodes **KRISS KROSS STROPPER**

RHODES MFG. CO. 1418 PENDLETON AVE. St. Louis, Mo. Dept. B-212

Largest Manufacturers of Mechanical Strroppers in the World

Rhodes Mfg. Co., Dept. B-212
1418 Pendleton Ave., St. Louis, Mo.

Without obligation, please send me illustrated description and full details of your special introductory offer on KRISS-KROSS super-stropper and FREE 3-way razor.

Name.....

Address.....

Town.....State.....

( ) Check here if interested in making money as authorized KRISS-KROSS representative.